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Economic consequences of personality, knowledge, and intellectual virtues

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Economic Consequences of Personality, Knowledge, and Intellectual Virtues

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Economic Consequences of Personality, Knowledge, and Intellectual Virtues

PhD thesis

to obtain the degree of PhD at the
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on the authority of the
Rector Magnificus Prof. E. Sterken
and in accordance with
the decision by the College of Deans.

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1 Introduction

1.1 Background

In microeconomics, preferences play a crucial role in explaining choices (Bowles 2006). But where do preferences come from? In addition to institutions and incentives (Acemoglu, Johnson, and Robinson 2005), individual characteristics such as personality (Almlund et al. 2011), knowledge (Lusardi and Mitchell 2014), and intellectual virtues shape preferences (Peterson and Seligman 2004).

We investigate the associations between personality, knowledge, and intellectual virtue with economic decision making, including risk-taking, investment, and mortgage decisions. While personality and knowledge are well-known concepts, intellectual virtues are perhaps less familiar. Roughly, intellectual virtues are acquired character traits that support gaining knowledge and understanding (Zagzebski 1996). In contrast to personality, intellectual virtues specifically capture traits supporting knowledge acquisition (Baehr 2013).

The focus of this thesis is on the measurement of personality, knowledge, and intellectual virtue. Empirical studies rely on good instruments to measure the constructs they seek to investigate. Each chapter deals with the problem of measurement, if in different ways. Chapter 2 uses an existing and well-studied measure of personality based on the Big Five personality traits, but applies it in a new context, namely a developing country (Maples et al. 2014). While we rely on an existing instrument, administering the instrument in a very different cultural context yields new insights. Chapter 3 investigates the relationship between knowledge and mortgage decisions through the lens of a newly developed instrument, the Mortgage Literacy Questionnaire. The Mortgage Literacy Questionnaire is the first instrument to measure

financial literacy that includes questions on different mortgage types, including their fiscal and legal implications (Van Rooij, Lusardi, and Alessie 2011b). Chapter 4 develops and validates the Intellectual Virtue Scale, a new instrument to measure intellectual virtue (Fairweather and Zagzebski 2001). In chapter 5, we use the Intellectual Virtue Scale to inquire into the associations of intellectual virtue with financial literacy, as well as diligent financial decision making.

While each chapter stands on its own, the crosscutting theme of the economic consequences of individual characteristics deserves attention. Individual characteristics were long neglected among the factors influencing economic decision making. The long dominant approach in economics regarded people as rational agents on a quest to maximize utility (Mas-Colell, Whinston, and Green 1995). People's utility function was determined by a stable, complete, and transitive preference ordering over all available choices. It was not the place of economics to further inquire into the origin of these preferences. Within this paradigm, economists derived general predictions about economic behaviour based on given preferences and prices, which themselves were the results of supply and demand on clearing markets. Individual characteristics such as personality, knowledge, and other cognitive characteristics were excluded from the analysis. This thesis contributes to putting these individual characteristics, always at play in economic decision making, into the study of economic decision making.

1.2 Personality

Research on personality has a long tradition in psychology (for a review, see Robins, Fraley, and Krueger 2009). The dominant model to assess personality measures the 'Big Five' personality traits: agreeableness, extroversion, openness to experience, conscientiousness, and neuroticism (Donnellan et al. 2006). Prior studies have demonstrated that personality is associated with socioeconomic outcomes (Borghans et al. 2008; Bowles, Gintis, and Osborne

2001). Personality traits are a powerful predictor of leadership abilities, job performance, longevity, and college grades (Barrick and Mount 1991). But these studies have been conducted almost exclusively in a developed country context (Almlund et al. 2011).

Our contribution is to study the relationship between personality and economic decision making in a developing country context, namely among rural farmers in Meru County, Kenya. Taking the research on personality to a developing country context contributes to our understanding of how personality shapes investment decisions and risk taking in a poor rural context.

1.3 Knowledge

Economists have also begun to investigate the relationship between knowledge and economic decision making. The literature on financial literacy has specifically explored the relationship between financial knowledge and financial decision making (Lusardi and Mitchell 2011b; 2014). People scoring higher on financial literacy are more likely to manage wealth effectively (Hilgert, Hogarth, and Beverly 2003), invest in the stock market (Van Rooij, Lusardi, and Alessie 2011b), select mutual funds with lower fees (Hastings and Tejeda-Ashton 2008), and plan ahead for retirement (Lusardi and Mitchell 2011a).

An important next step is to investigate a broader range of economic outcomes that may be associated with financial literacy (Lusardi and Mitchell 2014). We study the effects of financial literacy on mortgage decisions (Van Rooij, Lusardi, and Alessie 2011b). But existing measures of financial literature focus exclusively on general concepts such as the time value of money or inflation. A more targeted measure specific to mortgages is important because we cannot take for granted that people with a good general understanding of financial concepts also understand the legal and fiscal repercussions of different types of mortgages. Our contribution

is to develop a new instrument to measure mortgage literacy specifically. Mortgage literacy focuses on the knowledge relevant to selecting a mortgage and managing risks emerging from mortgages. The mortgage literacy questionnaire allows us to elicit specific competencies required in selecting a mortgage and managing mortgage risk. In particular, we consider legal and fiscal aspects of mortgage decisions. Understanding what people know – and do not know – about mortgages and to what extent such knowledge matters for making mortgage decisions can inform policy decisions in areas ranging from financial stability to customer protection.

1.4 Intellectual Virtues

Intellectual virtues are qualities of individuals that support processing information and dealing with information conscientiously (Morton 2012). The relationship between intellectual virtues and economic decisions has received little attention to date (Peterson and Seligman 2004). We take up this task by developing and applying the Intellectual Virtue Scale, a new instrument to measure intellectual virtue.

We focus on five intellectual virtues: *Love of Knowledge* or curiosity is the disposition to actively and purposefully seek knowledge and understanding. *Open-mindedness in gathering information* is the disposition to take up different standpoints and perspectives in seeking out evidence and being impartial in appraising the reliability of sources of information. *Conscientiousness in evaluating information* is the disposition to evaluate evidence methodically, thoroughly, and carefully. *Humility in belief formation* is the disposition to proportion the strength of your beliefs to the strength of your evidence. *Intellectual Courage* is the disposition to pursue knowledge and understanding even if this may negatively affect your wellbeing.

How are intellectual virtues relevant to economic decision making? The Intellectual Virtue Scale evaluates traits related to motivating people to learn relevant information, and to be more competent in dealing with information. Therefore, we expect intellectually virtuous people to have more financial knowledge and understand economic concepts better. Moreover, we expect intellectually virtuous people to be more aware of the limits of their knowledge and to be more reflective in making financial decisions. For instance, we expect intellectually virtuous people to score higher on traditional measures of financial literacy and to display higher self-awareness of the extent of their financial knowledge. Moreover, we expect financially literate people to make financial decisions more diligently.

We study the relationship between intellectual virtue and the acquisition of financial knowledge and diligence in financial decision making. Applying the Intellectual Virtue Scale to mortgage decisions yields new insights into what shapes economic decision making. Understanding to what extent intellectual virtue matters for economic decision making is also important for policy making, including for targeting financial education programmes and designing teaching curricula.

1.5 Methodology

Economists once assumed that people act on the far-sighted evaluation of the consequences of their actions in light of exogenously determined rational preferences (Walras 2013; Mas-Colell, Whinston, and Green 1995). But this Walrasian approach has been enriched and complemented by alternative approaches (Bowles 2006). The assumption of a rational set of preferences makes way for insights from behavioural economics (Kahneman and Tversky 1979; Mullainathan and Thaler 2001; Thaler and Sunstein 2008). The assumption that people evaluate consequences far-sightedly is replaced by the notion that people are rational only within bounds, relying on ‘fast and frugal’ heuristics in evaluating actions (Simon 1982;

Gigerenzer and Selten 2002; Kahneman 2003). The assumption of exogenously given preferences has been challenged as well: new approaches model the interactions between economic institutions and values and preferences, showing how preferences are shaped by economic interaction (Leibenstein 1950; Gerber and Jackson 1993; Bowles 1998).

By abstracting from the specifics of institutions, and the cognitive characteristics of people, the Walrasian approach yielded general predictions about economic outcomes based on general equilibrium modelling. Taking into account behavioural biases and heuristics, limited cognitive capacities, and endogenous preference formation requires a more empirical approach, which casts doubt on the generality of many of the predictions yielded by the Walrasian paradigm (Bowles 2006).

This thesis contributes to a departure from the Walrasian approach along three dimensions. First, the research questions and methodology are informed by neighbouring disciplines, particularly psychology, law, and philosophy. From psychology, we have learned about the crucial role personality plays for decision making (Borghans et al. 2008; Barrick and Mount 1991; Brown and Taylor 2014). From philosophy, we draw inspiration for the Intellectual Virtue Scale (Zagzebski 1996; Baehr 2011; Montmarquet 1993). We adopt psychometric scale development methodology to construct and validate the Intellectual Virtue Scale (DeVellis 2016; Hinkin 1995). We have learned from law that the legal and fiscal context is of central importance for economic decisions (Deakin et al. 2017), which inspired us to develop the Mortgage Risk Questionnaire.

Second, this thesis is very much focused on the empirical details of the phenomena we seek to measure. Theory is the backbone of economics. Yet general hypotheses need to be tested by empirical case studies. In particular, we emphasize the task of getting good measures of the constructs we seek to study in the first place. We collect various types of data from different

sources depending on the task at hand. To obtain the data we use in chapter 2, we conduct a large-scale field experiment with farmers from Meru County, Kenya. The field experiment involves a 'lab-in-field experiment' in the form of a risk game to uncover the risk preferences of participants (Gerber and Green 2012). We also administer questionnaires to participants to assess personality and elicit economic choices (Levitt and List 2009). For validating the Intellectual Virtue scale in chapter 4, we administer candidate items to participants recruited on Amazon Mechanical Turk, a crowdsourcing Internet marketplace (Buhrmester, Kwang, and Gosling 2011). For the studies presented in chapters 2 and 5, we gather data on mortgage literacy and the associations between intellectual virtue and financial literacy through an online questionnaire administered to the participants of a Dutch household panel (Teppa and Vis 2012). In each chapter except for chapter 2, we invent new instruments to measure the individual characteristics the impact of which on economic decision making we seek to understand.

Third, we challenge the generalizability of previous studies. In chapter 2, we take the research on the relationship between personality and economic decision making to a developing country. We find associations between personality and economic decision making in our field study different from previous studies undertaken in developed countries. We also challenge generalizability by introducing a domain-specific measure of financial literacy. In chapter 3, we show that general measures of financial literacy do not find significant associations between financial literacy and perceived mortgage risk as well as the likelihood to fix mortgage interest rates. Our new domain-specific measure of mortgage literacy, however, does show significant associations with mortgage risk and rate-fixing behaviour. These results suggest that *how* we measure constructs of interest and *where* we measure is crucial for economic decision making.

1.6 Outline

The overarching research question of the thesis is whether and to what extent individual characteristics affect economic decision making. The chapters separately address the following research questions:

Chapter 2: Does personality affect risk taking, investment decisions, and desire for credit?

Chapter 3: Does knowledge about mortgages affect the riskiness of mortgages taken?

Chapter 4: How can intellectual virtue be measured?

Chapter 5: Does intellectual virtue improve knowledge about finance and financial diligence?

In chapter 2, we investigate how personality influences economic decision making, with a lab-in-the-field experiment as well as observational data from rural Kenya. Our sample is composed of smallholders with an income of less than $1 per day, from 40 farmer communities in Meru County. More than 90% in our sample are women. We find that particular personality profiles are associated with the risk propensity of farmers, their investment decisions, their desire for credit, and the amount of formal and informal credit they obtain. Interestingly, we find that other traits than those suggested by the existing literature matter. We find no correlation with the traits of neuroticism and extroversion, which have been identified as important in developed country studies. By contrast, agreeableness, conscientiousness, and intellect are significantly correlated with our outcome measures. These results shed new light on the relationship between personality traits and economic decisions, and contribute to the understanding of how personality shapes investment decisions and risk taking in a poor rural context.

In chapter 3, we study the relationship between mortgage literacy and mortgage risks with a newly designed Mortgage Literacy Questionnaire using Dutch household data. The Mortgage Literacy Questionnaire evaluates the domain-specific knowledge of households about

mortgages, including the legal and fiscal implications of different types of mortgages. We find that mortgage literacy is distinct from basic and advanced financial literacy. A significant number of households is financially literate but mortgage illiterate. We demonstrate that mortgage literacy is associated with lower perceived mortgage risk, and with how well households hedge mortgage risk. Our results suggest that knowledge about mortgage products and their legal and fiscal environment matters considerably for financial choices regarding mortgages.

In chapter 4, we develop and validate the Intellectual Virtue Scale, a new measure of intellectual virtues. Intellectual virtues are acquired character traits that support gaining knowledge and understanding. We develop a 20-item scale, measuring five intellectual virtues with four items each: love of knowledge, openness in gathering information, conscientiousness in processing information, humility in belief formation, and intellectual courage. The validation studies include an exploratory and a confirmatory factor analysis with almost 1,000 participants each, demonstrating that the Intellectual Virtue Scale has a stable factor structure and is internally reliable. We also demonstrate that intellectual virtue is distinct from related constructs such as personality, moral virtue, critical thinking, and professional scepticism.

In chapter 5, we study the relationship between the Intellectual Virtue Scale and financial knowledge and diligent financial decision making. A substantial body of literature suggests that people who are more financially literate make better financial decisions. We study the intellectual qualities supporting financial literacy. In particular, we investigate whether intellectual virtue is associated with greater financial literacy and with a more reflective and conscientious approach to financial decision making. We measure the extent to which participants in a representative Dutch household panel display intellectual virtue using the Intellectual Virtue Scale. We find that intellectually virtuous people are more financially

literate, display greater self-awareness about their financial knowledge, and are more likely to compare financial advisors.

2 Personality Traits and Economic Decisions in Rural Kenya

2.1 Introduction

Personality affects investment decisions of households, which in turn influence income and consumption (Guiso, Haliassos, and Jappelli 2002; S. Brown and Taylor 2008; S. Brown et al. 2005; Crook and Hochguertel 2007). In rural areas this often means deciding how and how much to invest in farming (Bingen, Serrano, and Howard 2003; Reardon and Vosti 1995; Reardon et al. 2000; Rodrik 1991). Aversion to risk may trigger lower investments in risky farming projects, even when their expected outcome is very appealing, on average. This "investment gap" – or the suboptimal level of investments in agriculture – hinders overall economic growth, especially in developing countries. FAO estimates the gap between current global investments in agriculture and required annual gross investments to be around 50% of the former (FAO 2009). Economic literature identifies several reasons underpinning this gap, including financial, physical and human capital bottle-necks. Psychological literature instead has a longstanding interest in the role of personality in determining life choices, including economic choices (Snyder and Deaux 2012; Almlund et al. 2011; Borghans et al. 2008). Within this framework, the Big Five personality traits have shown to be unrelated to life events and stable across time (Cobb-Clark and Schurer 2012).

This study focuses on the role of personality in guiding economic decisions in a developing country context. We study the relationship between the Big Five personality traits and economic decision making among poor smallholders in rural Kenya. The main contribution of this study is to investigate whether and how personality predicts economic decision-making concerning risk taking, investment decisions, and the desire and capacity to obtain credit. To our knowledge, we conduct the first large scale study of personality of Kenyan smallholders

and relate their personality profiles to economic outcomes. We also describe the challenges and limitations of applying standard measurement instruments of personality in rural Kenya.

Prior studies of the role of personality traits for socioeconomic outcomes have been conducted almost exclusively in a developed country context (S. Brown and Taylor 2014; Bucciol and Zarri 2017; Almlund et al. 2011; Borghans et al. 2008; Caliendo, Fossen, and Kritikos 2012; Heineck and Anger 2010; Snyder and Deaux 2012; Mayfield, Perdue, and Wooten 2008). While these studies provide ample evidence that personality traits are a powerful predictor of socioeconomic outcomes – including leadership abilities, job performance, longevity, and college grades – the influence of personality specifically on economic outcomes has hardly been studied in developing country contexts. An exception is a private sector initiative using measurements of personality to predict creditworthiness in developing countries. A pilot study in Peru conducted by one of these initiatives indicates that measures of personality traits may be predictive of creditworthiness (EFL 2014). Nonetheless, overall little work has been done on the relationship of personality and economic decision making in developing countries.

But understanding the determinants of investment decisions and risk taking is critical in developing countries. For the smallholders in our sample, a wrong decision can force the household to go hungry for long stretches of time. By contrast, a lucrative investment may lift a household out of poverty. We focus on the influence of personality on risk attitudes, investment decisions, and the desire and capacity to take out credit. Our study is based on a lab-in-the-field experiment in rural Kenya with smallholders, as well as observational data on their farming investments and bank loans. The majority of participants have an income of less than $1 per day. More than 90% of the farmers in our sample are women, in line with the gender balance in the population for smallholders in Kenya.

Similar to the literature based on samples from developed countries, we find significant associations between personality and economic decision making. But there are important

differences concerning *which* personality traits are associated with economic decisions, and the *direction* of the impact of personality traits on economic decisions. Prior research has found that agreeableness and neuroticism are negatively correlated with risk taking behaviour in risk games (Borghans et al. 2009). By contrast, we find a significant positive association between agreeableness and risk taking and a significant negative association between intellect and risk taking in the risk game we conducted. Importantly, neuroticism makes no significant contribution. We also find individuals who are more agreeable and more conscientious invest more in farming activities, while extroversion, neuroticism, and intellect are once more not significantly correlated. Concerning household debt, prior research on developed countries has shown that extroversion is associated with higher debt levels (S. Brown and Taylor 2014). By contrast, we find that higher levels of agreeableness are associated with a desire to hold larger amounts of debt. This is in some tension with findings from the US according to which agreeableness is associated with lower levels of risky financial assets (Bucciol and Zarri 2017). We also find that intellect is positively related to the total amount of formal and informal credit that people manage to obtain throughout the farming season.

As we discuss in detail in Appendix 4, measurement challenges in particular for the traits of conscientiousness and intellect may account for some of the differences we find with studies in developed countries. Note as well that we need to drop a large part of the sample, because it turns out that many older and less educated farmers may not have fully grasped the nature of the exercise. But our findings concerning the traits of agreeableness, extroversion, and neuroticism are not easily explained away by measurement problems, as these subscales pass typical psychometric standards. Taken together, our findings challenge the generalizability of studies of the impact of personality on economic decision making conducted in developed countries. They shed new light on the relationship between personality traits and economic

decisions, and contribute to the understanding of how personality shapes investment decisions and risk taking in a poor rural context.

The remainder of the chapter is structured as follows. Section 2.2 introduces the experiment we have conducted and describes the farmers. Section 2.3 describes how we measure personality and the dependent variables. Section 2.4 presents and discusses regression results. Section 2.5 discusses strengths and limitations of the current investigation, and points to opportunities for further research.

2.2 Context, sample and experiment

We collected personality data and data about economic decision making from 803 farmers, a randomly selected subset of farmers from 40 farmer communities in Meru county, Kenya. Table 2.1 shows the demographic characteristics of the sample. Participants have a median yearly income from farming of 15,000 Kenyan Shilling (USD 145). Hence the typical farmer in our sample lives well below the poverty line of $1/day. In Kenya, 38% of the population live below the poverty line (Wiesmann, Kiteme, and Mwangi 2015). It is notable that 91% of our sample are female. A typical participant is 45 years old, lives in a household with five members, and has seven years of education. Our survey participants are older than the population average in Meru. In the general population, only 25% are older than 34. (Katindi Sivi Njonjo 2013) The household size is at the upper end of the population average in Meru county, where 42% of households have more than 3 members (Katindi Sivi Njonjo 2013). Educational attainment is roughly in line with the county average. In our sample, 12% received no formal education at all, which is lower than the county average of 21% (Katindi Sivi Njonjo 2013). However, 41% of respondents in our sample have less than 7 years of education, the length of primary school in Kenya. Less than 10% have completed secondary education, which is less than the county average of 18% (Katindi Sivi Njonjo 2013).

Table 2.1: Descriptive statistics

Variable	Mean	Median	SD	Min	Max
Age	46.21	45	13.94	15	90
Household size	5.67	5	1.99	1	15
Years of Education	6.3	7	3.7	0	16
Total Land (Acres)	2.57	2	2.47	0	20
Average Income from Farming/yr (Ksh)	25,007	15,000	33,949	0	350,000
Maize Production (kg)	212.26	90	455.99	0	6,200
Sorghum production (kg)	10.15	0	68.7	0	990
Soy production (kg)	0.42	0	5.44	0	90
Sunflower production (kg)	1.38	0	9.18	0	100
Bean production (kg)	57.68	20	112.32	0	1,500

Our sample consists of farmers, who represent the bulk of the Kenyan population: In 2006, almost 75% of working Kenyans worked as farmers (Library of Congress 2007). The staple crop is maize, with a median production of 90 kg in our sample. The second most popular produce in our sample is beans, with a median production of 20 kg. Sorghum, Soy, and Sunflower are produced by a minority of farmers in comparatively small quantities. This is all in line with production in Kenya generally. In addition, other smallholders in Kenya also grow bananas, potatoes, and peas.

2.3 Data

We gathered data about the economic and financial situation of participants, their risk-propensity and investment decisions, their expectations of the future, and their personality. The present study uses the personality data as an independent variable. The variables collected on risk-propensity, investment decisions, and the desire to take out credit as well as the amount of credit obtained serve as dependent variables.

2.3.1 Measuring Personality

We use a version of the Big Five personality test drawn from the International Personality Item Pool to measure the personality of participants (Johnson 2014; Donnellan et al. 2006). Our measures capture the personality of participants along five traits: intellect, extroversion, conscientiousness, agreeableness, and neuroticism (Donnellan et al. 2006).

Intellect is a personality trait that ranges from curious to cautious. Intellect should not be confused with intelligence. Rather than measuring IQ, intellect measures an intellectual style. Intellectual people appreciate art, adventure, new and curious ideas, and are open to a wide range of experiences.

Extroversion ranges from energetic to reserved. Extroverted people are sociable, assertive, and seek stimulation in the company of others. People low on extroversion have more reflective and reserved personalities.

Conscientiousness ranges from organized to careless. Conscientious people are dependable, dutiful, and self-disciplined. People low in conscientiousness are highly flexible and spontaneous.

Agreeableness ranges from friendly to detached. Agreeable people are cooperative and compassionate, and tend to trust other people. People low in agreeableness tend to be competitive and argumentative.

Neuroticism ranges from sensitive to confident. Neurotic people experience unpleasant emotions such as anxiety, anger and vulnerability easily. People low in neuroticism are emotionally stable, but can be seen as unconcerned or uninspiring.

We used a 25-item questionnaire to assess these five major personality traits. The questions are listed in Appendix 1. Each of these traits can be broken down into six facets, which can be measured individually as well. For instance, the trait of agreeableness breaks down into the following six facets: trust, morality, altruism, cooperation, modesty, and sympathy. We do not measure all traits at facet level to limit the cognitive load on participants. Focussing on selected facets reduces survey fatigue by keeping the survey at a manageable length. We select the following facets that may be relevant to economic decision making: adventure, altruism, anxiety, assertiveness, caution, dutifulness, excitement seeking, morality, motivation, self-consciousness, and trust. We map these facets to their respective traits in Appendix 1. Excluding facets seems warranted in the light of the hypotheses we are seeking to test. It is difficult to see how, for instance, the facet of artistic interest would explain economic or financial outcomes. The questions we use to measure the facets are listed in Appendix 1.

The items we selected to measure personality traits and facets are from a pool of questions which have been shown to be applicable across a wide range of countries and cultural contexts (McCrae and Allik 2002). However, no translation of the items into Kimeru, the language of the target population, was available. We prepared our own translation in three steps. First, we asked a translator whose native language is Kimeru to translate the items from English to Kimeru. Second, we asked a different native Kimeru translator to translate the Kimeru items back into English. We asked both translators to decide on a common translation based on our comments where issues came up in the back translation, which was the case in about a quarter of cases. In a third step, we validated problematic items with two native Kimeru speakers, which led to another substantial revision of the questionnaire.

Despite the intercultural success of the items reported in other studies, about 10% of items proved very difficult to translate into Kimeru in a way that is meaningful to farmers. For instance, the item "I am not interested in abstract ideas" proved problematic. The initial translation translated back into English as "I am not interested in ghosts". It proved very difficult to hone in on the concept of "abstract ideas" when we refined the translation into Kimeru. Similarly, "I easily get stressed" proved challenging to translate. It was difficult to find a translation for "stressed" that situates the feeling in the middle ground between "overwhelmed" and simply "working".

These two examples illustrate that despite the robust translation process, problems with the translation are a possible source of bias in the data. In Appendix 4 we show that some of the questions in the personality survey were probably misunderstood by the respondents. Problems with the translation are one of the likely sources of these problems. However, the appendix also shows that a subsample of the population, in particular younger and better educated people, did understand the questions better than older or less educated participants.

As discussed in detail in the appendix, some traits and facets fall short of psychometric standards for the whole sample. We address these shortcomings by excluding three of the eleven facets with unacceptably low internal consistency from the analysis (morality, motivation, and self-consciousness). Moreover, we exclude from the analysis all respondents who are older than 34, unless they have more than 11 years of formal education. This severe restriction of the survey sample is partly motivated by a difference that emerged during the data gathering between younger and, for Kenyan standards, older farmers (only 25% of Kenyan population is older than 34). Whereas older and less educated farmers struggled to make sense of the exercise we put them through, the younger generation was more amenable to personality testing. Moreover, as discussed in appendix 4, the psychometric properties of the responses from this subgroup are much better than for the sample as a whole. With the exception of the three problematic facets mentioned above, the responses to the questionnaire meet psychometric standards. As a result, our final sample has 245 responses. As we show in the appendix, these respondents are similar to the whole sample with respect to all demographic characteristics other than age and educational background. In Appendix 5, we show that our qualitative results are quite robust for different specifications of the subsample.

In what follows, we describe the personality profiles of the final sample. Let us first consider the Big Five personality traits. Figure 2.1 shows histograms of the five personality traits as measured in our sample. Note that we have scored all traits and facets on a five-point scale, consistent with the answer options ranging from “strongly disagree” (1) to “strongly agree” (5).

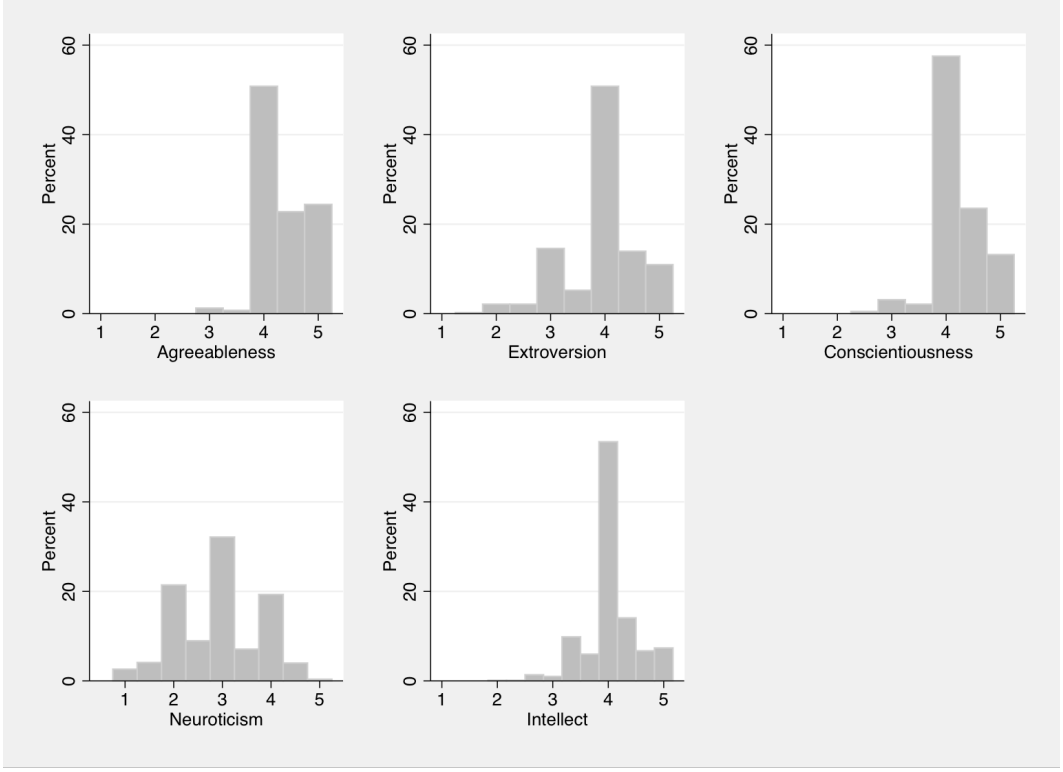

Figure 2.1: Histograms of personality traits.

Table 2.2 shows means and standard deviations for the sample and a benchmark. The results for the benchmark sample are drawn from the validation study of the items we used to assess the Big Five traits. The survey was administered to 2,663 freshman undergraduate students across 10 colleges and universities in the United States (Donnellan et al. 2006, 194).

Table 2.2: Means and standard deviations of personality traits.

	Sample		Benchmark	
	Mean	SD	Mean	SD
Agreeableness	4.31	0.47	4.01	0.69
Conscientiousness	4.17	0.45	3.42	0.78
Intellect	4.07	0.45	3.74	0.76
Extroversion	3.91	0.70	3.28	0.90
Neuroticism	2.82	0.87	2.62	0.83

Differences between our sample and the benchmark sample are considerable: Agreeableness 0.74 SD, Conscientiousness 1.75 SD, Intellect, 0.67 SD, Extroversion 0.97 SD, and Neuroticism 0.35 SD. For all traits, our sample shows higher means than the benchmark

sample. Moreover, for all traits except neuroticism, the standard deviation in our sample is considerably smaller than in the benchmark sample. Note that the means have an almost identical order in our sample and the benchmark sample, with the exception of the order of conscientiousness and intellect, which is reversed.

A possible explanation for these results is that respondents in our sample were more likely to select socially desirable answers. This hypothesis explains why our sample shows higher means and lower standard deviations for the socially desirable traits agreeableness, conscientiousness, intellect, and extroversion, but a similar mean and standard deviation for neuroticism.

Let us now turn to the facets in our sample. Figure 2.2 shows histograms of the personality facets for our sample.

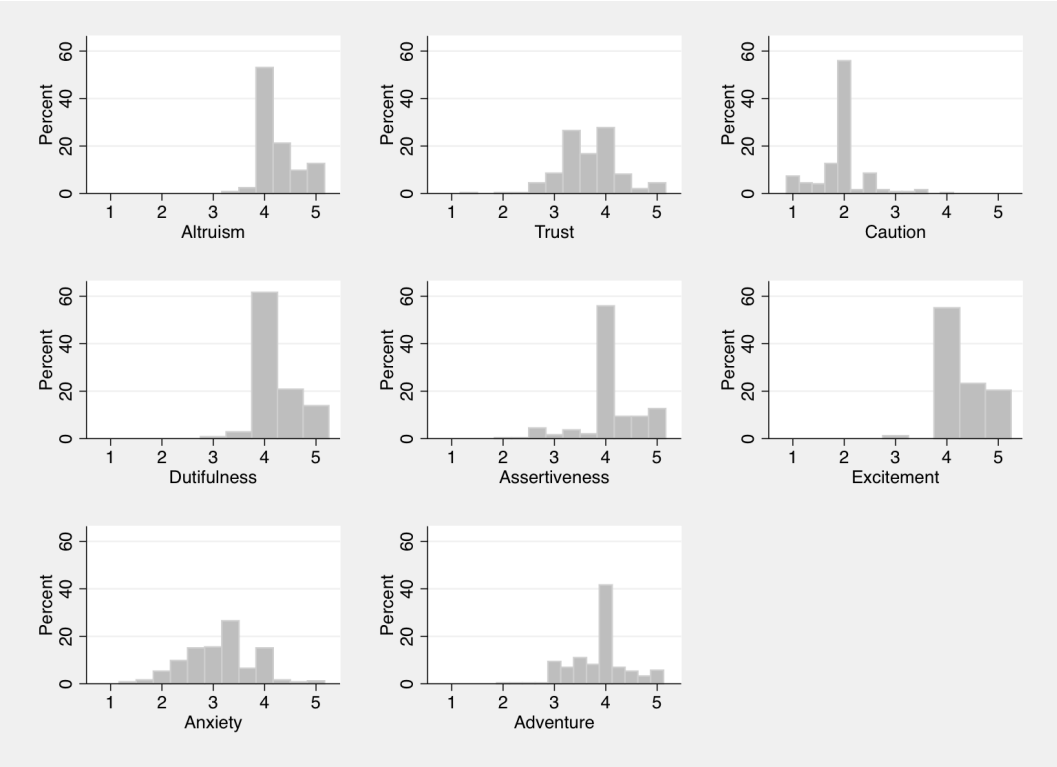

Figure 2.2: Histograms of personality facets

Table 2.3 shows means and standard deviations for the personality facets of the sample and a benchmark. The benchmark consists of 23,994 participants (8,764 male, 15,229 female) who completed an online version of the IPIP personality questionnaire, mainly in the US. The mean age in the benchmark is 26.2, with an SD of 10.8 years (Johnson 2005).

Table 2.3: Means and standard deviations of personality facets for sample and benchmark

	Sample		Benchmark	
	Mean	SD	Mean	SD
Excitement	4.31	0.42	4.08	0.71
Altruism	4.25	0.37	3.31	0.94
Dutifulness	4.22	0.40	3.20	1.04
Assertiveness	4.10	0.56	4.00	0.69
Adventure	3.88	0.54	3.57	0.91
Trust	3.68	0.57	3.36	0.91
Anxiety	3.14	0.68	3.12	0.96
Caution	1.95	0.47	3.22	0.84

With the exception of caution, mean scores in our sample are considerably higher than in the benchmark, as in the case of traits. Altruism and dutifulness show the strongest deviations from then benchmark sample, with a difference of more than two standard deviations. For the remaining facets, the means in our sample are between 0.1 and 0.7 standard deviations larger than in the benchmark sample. Standard deviations are also larger in the benchmark than in our sample. For most facets, standard deviations in our sample are between 50% and 80% smaller than in the benchmark sample. Dutifulness and altruism are outliers, with SDs that are more than 140% larger in the benchmark sample. The irregularities in means and standard deviations raises a red flag concerning data quality with dutifulness and altruism, something to watch out for when interpreting regression results.

Caution is a clear outlier. Its low mean score indicates a potential problem with data quality. A possible reason is that the items pertaining to caution are all reverse scored. Participants may have failed to pick up on the reverse keyed nature of the questions. But this explanation for the low mean value of caution needs to grapple with the fact that the facet of adventure is also

entirely reverse scored without showing low mean values. Another possible explanation is that there is a problem with the translation. This explanation faces the challenge that all four items equally contribute to the low mean scores. It does not seem likely that a translation issue affects four different items in a row, while affecting far fewer items pertaining to other facets. Still, the fact remains that mean values for caution are much lower than values for all other facets, and much lower than in the benchmark sample. This suggests that we should be very careful in interpreting results from the regression analysis with respect to caution.

These challenges to data quality should not distract from the observation that the order of means is almost identical in our sample and the benchmark sample. To recreate the exact order in the benchmark, altruism and dutifulness would need to move two ranks down, and caution needs to move one rank up. Since there are 40,320 possible ways in which eight elements can be ordered, it is remarkable that the ordering of the eight facts in our sample follows the ordering in the benchmark sample closely.

2.3.2 The Risk Game

We study the association of personality with the risk propensity of participants elicited by a risk game. We hypothesize based on existing literature that agreeableness and neuroticism are negatively correlated with risk taking behaviour in risk games (Borghans et al. 2009).

The setup of the risk game is as follows. Each participant is given 200 Kenyan Shilling ($2). Participants are asked to choose how much, if anything, they want to enter into a lottery. The outcome of the lottery depends on a coin flip. If participants win, they receive double the amount they entered into the lottery. If they lose, they receive half the amount they entered. Because the expected return on money entered into the lottery is positive, risk neutral rational players would enter the maximum amount of 200 Kenyan Shilling.

Given the positive expected return of the risk game, there is an argument to expect that intellect will be positively correlated with risk taking in the risk game. The reason is that intellect is positively correlated with intelligence (Dohmen et al. 2010). More intelligent participants should be more likely to understand the structure of the risk game, including the fact that the risk game has positive expected return. We expect that understanding the structure of the game should make participants more likely to gamble, holding other things equal. Call this the understanding effect of intellect on risk taking.

But there is also reason to expect a negative association between intellect and risk taking in our risk game. People scoring higher on intellect have been shown to be more vulnerable to stress, as measured by changes in cortisol levels before and after taking a stress-test (Oswald et al. 2006). Higher cortisol levels have in turn been shown to lead to higher risk aversion (Kandasamy et al. 2014). Thus, there is reason to expect a negative relationship between intellect and risk taking in the risk game due to the mediating role of stress. Call this the stress-effect of intellect on risk taking. It is an empirical question whether the understanding-effect or the stress-effect of intellect on risk taking dominate.

In fact, as Table 2.4 shows, many participants do not enter the lottery at all, and of those who do, the vast majority puts less than the maximum amount at risk. We use the proportion of money entered into the game as dependent variable to test our hypothesis.

Table 2.4: Tabulation of amounts entered into the risk game

Amount	Proportion	Frequency	Percent
0	0	45	18%
20	0.1	47	19%
40	0.2	36	15%
60	0.3	20	8%
80	0.4	5	2%
100	0.5	54	22%
120	0.6	2	1%
140	0.7	1	0%
160	0.8	2	1%
200	1	33	13%
Total	-	245	100%

2.3.3 Investment Decisions

We study the relationship between personality and investment decisions by using the total value of investment for farming that participants made during the season as dependent variable. The total value of investment is the sum of the value of the seeds and non-seed inputs. Non-seed inputs consist of labour, fertilizer, rent for mechanical aids, pesticides and other chemicals. In line with previous research, we expect investment volume to be associated with higher levels of intellect (Mayfield, Perdue, and Wooten 2008).

As the summary statistics in Appendix 2 show, the median total investment by farmers is 11,350 Kenyan Shilling ($100), or two thirds of their annual income from farming. Only about 5% of the total investment volume concerns seeds, with 95% concerning non-seed investments. 45% of non-seed investment concerns labour cost for help with planting, weeding, and harvesting. 37% of non-seed-investments are spent on fertilizer and other chemicals. Farmers spent 18% of non-seed investment on renting mechanical farming aids.

2.3.4 Credit

We ask participants about the amount of credit they would like to obtain for this season's farming activities. We expect that more extroverted people will desire more credit, based on research on household debt (S. Brown and Taylor 2014).

The reason to work with desired amounts of credit rather than the volume of credit obtained is that farmers in our sample are severely constrained from the supply side, as summary statistics in Appendix 2 show. 60% would have wanted to take out more credit than they obtained. The mean credit volume farmers in our sample desired to take out was 15,000 K.Sh. ($150). By contrast, farmers obtained on average only about one third of the desired sum. Poorly functioning credit markets are likely to interfere in the relationship between personality and the willingness of respondents to take out credit. As a result, the role of personality in

determining credit actually obtained, which we also report, must be the result of a combination of personality effects, including desired credit but also capacity to convince lenders to lend.

2.4 Results

In this section, we test whether the expectations derived from the literature pertaining to developed countries are fulfilled in our developing country context. We focus here on personality *traits* as independent variables. Including personality facets in addition to personality traits as independent variables would amount to double counting, because personality traits are constituted by personality facets.

We draw on the existing literature to specify controls (S. Brown and Taylor 2014, 200). We control for sex, age, age squared, years of schooling completed, the number of children below 15 in the household, the total household size, the agricultural income in an average year, a score for material assets,[1] a score of food insecurity, a measure of the likelihood of crops being affected by pest, and the total land farmed.

2.4.1 Personality and Risk Propensity

To test whether personality predicts risk propensity, we regress personality traits and facets on the share of money invested in the risk game. In Table 2.5, we first show the results for each separate trait (Columns 1-5) and then show all personality traits together in one regression (Column 6). Contrary to our expectation, neuroticism and agreeableness are not negatively associated with risk taking in the risk game. Instead, intellect and conscientiousness are negatively associated with risk taking when taken separately, even though conscientiousness turns insignificant in the full regression. Agreeableness in turn becomes significantly positive.

[1] To measure material assets, we construct a wealth factor score based in the questions in Table 2.15 in Appendix 2

A possible explanation for the negative association of conscientiousness with risk taking is that respondents consider it reckless to gamble with money, even if there is a positive expected return regardless of the amount invested. This explanation is consistent with the negative association of dutifulness, one of the facets of conscientiousness, with the share of money invested in the risk game (Appendix 3). The association with gambling is plausible, because we know that insurance is often framed as gambling in developing countries (Karlan et al. 2014). There is no obvious explanation based on the facet analysis for why intellect is negatively associated with risk taking in the risk game. Adventure is the one personality facet we evaluated that belongs to intellect. As Appendix 3 shows, adventure is positively, if not significantly, associated with the share of money invested in the risk game. In the case of agreeableness, it is possible that the facets of cooperation and sympathy which we have not assessed drive higher investment spending. The significant negative correlation of intellect with the share invested is robust to changing the outcome variable to a dummy which is 1 if any money has been invested at all, and zero otherwise (Appendix 6). The robust negative association between intellect and risk taking in the risk game can be explained by the stress-effect of intellect on risk taking we discussed in section 3.

Table 2.5: Personality traits and share invested in risk game

	(1)	(2)	(3)	(4)	(5)	(6)
Agreeableness	0.012					0.054**
	(0.019)					(0.024)
Extroversion		-0.024				-0.012
		(0.017)				(0.020)
Neuroticism			0.014			0.004
			(0.023)			(0.025)
Intellect				-0.055***		-0.063***
				(0.017)		(0.022)
Conscientiousness					-0.038**	-0.025
					(0.018)	(0.024)
Age	0.011	0.013	0.013	0.010	0.011	0.007
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Age^2	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Male	-0.010	-0.000	-0.011	0.001	-0.014	0.006
	(0.074)	(0.075)	(0.074)	(0.074)	(0.073)	(0.075)
Years of education	-0.000	-0.001	-0.000	-0.001	-0.003	-0.001
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Number of children	-0.016	-0.015	-0.015	-0.010	-0.017	-0.009
	(0.015)	(0.016)	(0.015)	(0.014)	(0.015)	(0.016)
Household size	-0.014	-0.014	-0.014	-0.017	-0.015	-0.019
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)
Food insecurity index	0.056**	0.050*	0.052*	0.046*	0.050*	0.053**
	(0.026)	(0.027)	(0.026)	(0.026)	(0.027)	(0.025)
Asset index	-0.032	-0.032	-0.030	-0.026	-0.030	-0.026
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Pest likelihood	-0.151***	-0.156***	-0.146***	-0.146***	-0.152***	-0.161***
	(0.048)	(0.049)	(0.050)	(0.047)	(0.048)	(0.048)
Total land farmed	0.015*	0.015**	0.015**	0.014*	0.012	0.016**
	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)	(0.007)
Average income	0.022*	0.023*	0.023*	0.024*	0.022*	0.022*
	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)
Constant	0.198	0.171	0.166	0.215	0.224	0.296
	(0.173)	(0.172)	(0.178)	(0.178)	(0.178)	(0.191)
Observations	237	237	237	237	237	237
R-squared	0.11	0.11	0.11	0.13	0.12	0.16

Cluster robust standard errors in parentheses (40). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2.4.2 Personality and investment decisions

To test whether personality predicts investment decisions, we regress personality traits and facets on the amount of money invested in this farming season on seeds, chemicals, fertilizer, mechanization, as well as hired labour during planting, weeding, and harvesting. In other

words, we are interested in looking at how much people invest given a certain amount of land, or how *intensely* they invest in their farm. We seem to be able to explain almost 50% of the variation in farm investments (R-squared).

Table 2.6: Regression of personality traits on farm investments

	(1)	(2)	(3)	(4)	(5)	(6)
Agreeableness	1768.8**					2532.5***
	(728.7)					(907.0)
Extroversion		-34.5				-208.3
		(534.2)				(555.7)
Neuroticism			-581.4			-448.6
			(600.5)			(505.5)
Intellect				444.9		439.6
				(655.1)		(867.5)
Conscientiousness					-1332.3*	-2593.3**
					(786.0)	(1076.3)
Age	870.5***	955.7**	936.3**	968.3***	912.5**	758.9**
	(314.3)	(355.2)	(350.4)	(355.2)	(368.3)	(309.3)
Age^2	-13.1***	-14.0***	-13.7***	-14.2***	-13.1***	-11.2***
	(4.2)	(4.6)	(4.6)	(4.6)	(4.7)	(3.8)
Male	5343.5*	5324.8	5349.9	5223.5	5174.4	5122.2
	(3105.7)	(3377.6)	(3402.5)	(3370.1)	(3481.1)	(3148.6)
Years of education	110.4	64.3	45.7	69.6	-6.1	-22.4
	(186.4)	(183.5)	(183.4)	(183.6)	(184.3)	(184.3)
Number of children	-191.0	-207.6	-226.0	-252.6	-250.1	-314.5
	(516.9)	(513.8)	(504.8)	(513.3)	(519.3)	(502.4)
Household size	-399.9	-370.1	-357.5	-346.3	-385.7	-411.7
	(292.8)	(307.7)	(308.2)	(302.4)	(310.7)	(292.9)
Food insecurity index	2018.0**	1582.5*	1640.4*	1646.6*	1467.2*	2038.0**
	(930.3)	(905.6)	(890.6)	(903.9)	(847.6)	(908.6)
Asset index	2979.2***	3035.3***	2979.3***	2994.5***	3082.7***	2954.5***
	(1006.1)	(1015.2)	(1002.3)	(1025.0)	(977.3)	(938.1)
Pest likelihood	505.0	806.6	704.8	799.7	686.9	-54.2
	(1445.0)	(1435.2)	(1472.4)	(1459.3)	(1439.4)	(1301.2)
Total land farmed	2624.7***	2535.0***	2513.0***	2535.3***	2462.5***	2515.9***
	(556.2)	(620.0)	(623.2)	(611.4)	(606.0)	(535.4)
Average income	1133.9***	1200.5***	1173.1***	1190.3***	1188.2***	1055.0**
	(402.7)	(424.9)	(426.1)	(419.3)	(430.6)	(393.4)
Constant	-10499.8*	-12560.3**	-11829.5*	-12797.3**	-11147.2*	-6718.1
	(5330.2)	(6206.9)	(6123.1)	(6208.9)	(6324.2)	(5134.5)
Observations	237	237	237	237	237	237
R-squared	0.47	0.45	0.45	0.45	0.46	0.51

Cluster robust standard errors in parentheses (40). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Agreeableness is positively, and conscientiousness is negatively, associated with the value of investments. The first is significant at the 1% level, in the full model including all traits. This

result is contrary to expectations based on results from developed countries. Based on the literature, we expected people scoring higher on intellect to invest more. While the coefficient of intellect is positive, it is not significant. The facet analysis in Appendix 3 does not suggest an explanation for the results pertaining to intellect or conscientiousness. However, two facets pertaining to agreeableness are related to farm investments. Altruism is significantly positively related, while trust is significantly negatively related. The effects are of roughly equal size. This suggests that the facets of cooperation and sympathy which we have not assessed drive higher investment spending. In the case of conscientiousness, the facets of self-efficacy and self-discipline which we have not assessed may conceivably explain the negative association with the value of investment.

2.4.3 Personality and credit

To test whether personality predicts desire to take out credit, we regress personality traits and facets on the amount of credit participants wanted to take out.

We find a positive association between agreeableness and the desire to take out more credit, significant at a 5% level. Based on the literature, we expected in contrast that more extroverted people would desire more credit. Extroversion has a positive sign as expected, but is not significant. The facet analysis in Appendix 3 shows that the analysed facets pertaining to agreeableness do not explain the result. This raises the possibility that omitted facets such as cooperation and sympathy determine the result.

Table 2.7: Regression of personality traits on amount of desired credit

	(1)	(2)	(3)	(4)	(5)	(6)
Agreeableness	1753.4*					2112.1**
	(956.9)					(1021.9)
Extroversion		720.2				370.0
		(798.0)				(947.3)
Neuroticism			95.0			480.6
			(752.5)			(745.5)
Intellect				200.8		-792.8
				(960.9)		(989.6)
Conscientiousness					434.2	-108.2
					(841.3)	(1028.3)
Age	-949.2	-890.7	-862.9	-859.6	-852.1	-991.9
	(843.0)	(846.4)	(837.6)	(868.1)	(851.6)	(820.6)
Age^2	11.2	10.7	10.4	10.3	10.1	11.8
	(10.8)	(10.8)	(10.7)	(11.1)	(10.9)	(10.6)
Male	5244.9*	4917.2	5205.9	5173.0	5256.7	5211.7
	(3018.8)	(3140.8)	(3131.0)	(3125.4)	(3155.0)	(3138.3)
Years of education	816.8**	785.6**	774.9*	773.9**	794.9**	834.9**
	(379.1)	(373.5)	(384.3)	(373.9)	(375.9)	(400.2)
Number of children	395.0	355.9	380.3	357.7	391.0	476.7
	(1107.2)	(1115.8)	(1112.6)	(1128.5)	(1099.9)	(1164.5)
Household size	86.8	119.7	114.6	127.2	121.7	28.8
	(440.8)	(449.6)	(438.8)	(427.9)	(443.2)	(430.3)
Food insecurity index	498.9	177.8	63.6	98.8	111.4	481.8
	(1086.1)	(1093.2)	(1129.0)	(1098.0)	(1101.2)	(1100.0)
Asset index	1331.1	1406.5	1396.9	1368.8	1372.4	1454.4
	(1258.9)	(1265.7)	(1281.0)	(1297.1)	(1271.8)	(1264.0)
Pest likelihood	597.7	1133.9	925.9	899.5	950.1	764.9
	(1696.6)	(1719.7)	(1716.0)	(1738.9)	(1733.1)	(1671.9)
Total land farmed	1659.6**	1548.7**	1573.1**	1570.3**	1593.0**	1676.4**
	(656.6)	(686.2)	(696.4)	(691.8)	(698.5)	(666.1)
Average income	350.6	405.9	420.6	411.8	420.0	370.5
	(421.0)	(457.5)	(466.4)	(453.4)	(452.3)	(442.2)
Constant	16734.0	15095.8	14593.3	14594.4	14255.3	17326.1
	(13301.2)	(13217.7)	(12971.5)	(13688.2)	(13426.2)	(12662.8)
Observations	237	237	237	237	237	237
R-squared	0.24	0.22	0.22	0.22	0.22	0.24

Cluster robust standard errors in parentheses (40). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Finally, we look at the amount of credit actually obtained (Table 2.8). In this case, we find that intellect is the sole driver of the amount of credit obtained from formal and informal sources.

Table 2.8: Regression of personality traits on amount of credit obtained

	(1)	(2)	(3)	(4)	(5)	(6)
Agreeableness	742.1					-161.6
	(599.6)					(631.2)
Extroversion		552.6				-122.3
		(814.3)				(864.0)
Neuroticism			345.5			941.0
			(925.0)			(922.6)
Intellect				2130.9*		2216.3**
				(1082.9)		(1086.8)
Conscientiousness					1278.4	561.0
					(760.4)	(740.0)
Age	167.3	183.5	213.4	268.5	242.9	330.3
	(409.5)	(409.9)	(401.5)	(419.9)	(409.8)	(398.0)
Age^2	-0.9	-1.0	-1.4	-2.2	-2.1	-3.1
	(5.5)	(5.5)	(5.4)	(5.7)	(5.4)	(5.4)
Male	5696.2	5456.0	5659.1	5265.2	5813.1	5289.4
	(4097.8)	(3972.6)	(4028.8)	(3988.7)	(4051.6)	(4009.5)
Years of education	526.4	518.0	518.8*	529.8	575.5*	585.2*
	(316.3)	(317.0)	(303.5)	(335.9)	(316.6)	(334.9)
Number of children	-1135.8	-1159.8	-1132.9	-1353.4	-1103.4	-1314.3
	(868.6)	(864.3)	(885.9)	(918.8)	(879.3)	(928.8)
Household size	119.3	134.3	124.6	244.9	147.1	238.2
	(512.7)	(526.8)	(527.9)	(557.1)	(529.6)	(565.3)
Food insecurity index	2982.7**	2883.1**	2770.7**	3084.8**	2917.6**	3004.0**
	(1185.9)	(1185.5)	(1128.2)	(1165.5)	(1157.2)	(1198.1)
Asset index	1023.1	1061.6	1080.8	847.3	1002.4	913.7
	(1206.6)	(1205.9)	(1176.0)	(1206.7)	(1195.7)	(1181.4)
Pest likelihood	1971.5	2276.3	2169.6	2017.4	2228.0	2241.5
	(1520.9)	(1421.3)	(1568.8)	(1473.9)	(1489.7)	(1477.8)
Total land farmed	-716.1	-770.3	-741.7	-747.6	-685.6	-688.0
	(489.9)	(476.7)	(474.8)	(474.6)	(468.1)	(478.3)
Average income	881.3**	901.2**	925.0**	862.5*	920.4**	917.0*
	(428.9)	(431.9)	(440.0)	(452.8)	(439.3)	(474.2)
Constant	-6294.9	-6855.5	-7575.1	-8375.4	-8489.9	-10416.7
	(8671.3)	(8752.3)	(8593.3)	(9066.2)	(8786.6)	(8587.4)
Observations	237	237	237	237	237	237
R-squared	0.13	0.13	0.13	0.15	0.13	0.15

Cluster robust standard errors in parentheses (40). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2.5 Discussion and Conclusions

We study whether and how personality influences economic decision making in a developing country. Our main contribution is to show that results from developed countries may not hold in developing countries. Based on experiments in developed countries, we formed hypotheses

concerning the relationships between personality traits and economic decision making. None of our expectations have been supported by the data. Instead, we found unexpected significant associations between personality traits and economic decision making. In particular, we found an unanticipated negative association between intellect and conscientiousness with risk taking in the risk game; a large positive association between agreeableness and the volume of investment as well as the desire to take out credit; and a large negative association between conscientiousness and investment.

There are a number of different possible explanations for these results. We cannot rule out that we fail to find some of the expected associations because of issues with data quality. The validity of most personality traits and facets we measured is low for the greater part of participants. This led us to the exclusion of some facets from the analysis and the restriction of our final sample to a subgroup of farmers for which validity measures pass critical thresholds. Whether data quality even in this subsample obscures results can only be explored in further research. Issues with data quality notwithstanding, we find highly statistically significant and unexpected relationships between personality and economic decision making.

A possible explanation for why we see different personality traits at play in our study than in studies reviewed from developed countries is that the superficial similarity between the respective economic decisions in developed and developing countries masks important differences. Differences may be of one of two kinds: on the one hand, the benchmark studies we considered from developed countries may tap into a different aspect of the economic decision we are considering. For instance, differences in the way risk games are set up may well activate different personality traits. Another example are investment decisions. The investment decisions our benchmark studies consider are rather different from the farming decisions farmers in our study need to make.

On the other hand, differences can arise in the significance or meaning of the same economic decision if placed in a different context. Consider for instance the risk game. In developed countries, participation in the risk game will likely be framed by participants as a trade-off between risk and reward. By contrast, some participants in our study may well have framed the risk game as involving a moral issue. The negative association with conscientiousness is not surprising in a culture in which investing money in the risk game is framed as gambling.

It should be noted that our study design does not preclude reverse causality: perhaps economic decisions influence personality, rather than the other way around. One reason to expect a causal impact of personality on economic investment decisions is that such a link has been established in numerous other studies that addressed reverse causality (Almund et al. 2011). While personality can be changed by experience and investment, other studies find the main direction of causation to run from personality to economic outcomes (Borghans et al. 2008). Big-Five personality traits are found to be stable for working-age adults over a four-decade period. Generally, intra-individual differences are unrelated to adverse life events and are not economically meaningful (Cobb-Clark and Schurer 2012).

The main implication for policy making we draw from our results is that personality traits matter in economic decision making, but we should not take the relationships observed in developed countries for granted in a developing country context.

Appendix 1 Survey Questions

Table 2.9: Survey Questions for the general Big Five trait assessment

Code	Item	Key	Trait
A1	I sympathize with others' feelings.	+	Agreeableness
A2	I suffer from others' sorrows.	+	Agreeableness
A3	I am not interested in other people's problems.	-	Agreeableness
A4	I am not really interested in others.	-	Agreeableness
C1	I start tasks right away.	+	Conscientiousness
C2	I like order.	+	Conscientiousness
C3	I often forget to put things back in their proper place.	-	Conscientiousness
C4	I make a mess of things.	-	Conscientiousness
C5	I neglect my duties	-	Conscientiousness
E1	I am the life of the party.	+	Extroversion
E2	I talk to a lot of different people at parties.	+	Extroversion
E3	I don't talk a lot.	-	Extroversion
E4	I keep in the background.	-	Extroversion
I1	I have a vivid imagination.	+	Intellect
I2	I'm full of ideas	+	Intellect
I3	I am quick to understand things.	+	Intellect
I4	I am not interested in theoretical discussions.	-	Intellect
I5	I have difficulty understanding abstract ideas.	-	Intellect
I6	I've difficulty imagining things	-	Intellect
I7	I do not have a good imagination.	-	Intellect
I8	I am not interested in abstract ideas.	-	Intellect
N1	I have frequent mood swings.	+	Neuroticism
N2	I get upset easily.	+	Neuroticism
N3	I am relaxed most of the time.	-	Neuroticism
N4	I seldom feel blue.	-	Neuroticism

Table 2.10: Mapping of facets to traits

Facet	Trait
Altruism	Agreeableness
Morality	Agreeableness
Trust	Agreeableness
Caution	Conscientiousness
Dutifulness	Conscientiousness
Motivation	Conscientiousness
Self-consciousness	Conscientiousness
Assertiveness	Extroversion
Excitement seeking	Extroversion
Anxiety	Neuroticism
Adventure	Openness

Table 2.11: Survey Questions Facet Assessment

Code	Item	Key	Facet
Ad1	I prefer to stick with things that I know.	-	Adventurousness
Ad2	I dislike changes.	-	Adventurousness
Ad3	I don't like the idea of change.	-	Adventurousness
Ad4	I am attached to conventional ways.	-	Adventurousness
Al1	I make people feel welcome.	+	Altruism
Al2	I love to help others.	+	Altruism
Al3	I am concerned about others.	+	Altruism
Al4	I turn my back on others.	-	Altruism
An1	I worry about things.	+	Anxiety
An2	I fear for the worst.	+	Anxiety
An3	I am afraid of many things.	+	Anxiety
An4	I get stressed out easily.	+	Anxiety
As1	I take charge.	+	Assertiveness
As2	I try to lead others.	+	Assertiveness
As3	I take control of things.	+	Assertiveness
As4	I wait for others to lead the way.	-	Assertiveness
Cau1	I jump into things without thinking.	-	Cautiousness
Cau2	I make rash decisions.	-	Cautiousness
Cau3	I rush into things.	-	Cautiousness
Cau4	I act without thinking.	-	Cautiousness
Du1	I keep my promises.	+	Dutifulness
Du2	I tell the truth.	+	Dutifulness
Du3	I break my promises.	-	Dutifulness
Du4	I get others to do my duties.	-	Dutifulness
Ex1	I love excitement.	+	Excitement-seeking
Ex2	I seek adventure.	+	Excitement-seeking
Ex3	I love action.	+	Excitement-seeking
Ex4	I enjoy being reckless.	+	Excitement-seeking
Mor1	I use flattery to get ahead.	-	Morality
Mor2	I know how to get around the rules.	-	Morality
Mor3	I cheat to get ahead.	-	Morality
Mor4	I take advantage of others.	-	Morality
Mot1	I work hard.	+	Motivation
Mot2	I do more than what's expected of me.	+	Motivation
Mot3	I set high standards for myself and others.	+	Motivation
Mot4	I am not highly motivated to succeed.	-	Motivation
S1	I find it difficult to approach others.	+	Self-Consciousness
S2	I am easily intimidated.	+	Self-Consciousness
S3	I am not embarrassed easily.	-	Self-Consciousness
S4	I am able to stand up for myself.	-	Self-Consciousness
T1	I trust others.	+	Trust
T2	I believe that others have good intentions.	+	Trust
T3	I trust what people say.	+	Trust
T4	I distrust people.	-	Trust

Appendix 2 Summary statistics

Table 2.12: Summary Statistics

Variable	Mean	SD	Median	Min	Max
Traits					
Agreeableness	4.31	0.47	4.00	3.00	5.00
Extroversion	3.91	0.70	4.00	1.50	5.00
Neuroticism	2.82	0.87	3.00	1.00	5.00
Intellect	4.07	0.45	4.00	2.67	5.00
Conscientiousness	4.17	0.45	4.00	2.50	5.00
Facets					
Altruism	4.25	0.37	4.00	3.33	5.00
Trust	3.68	0.57	3.67	1.33	5.00
Caution	1.95	0.47	2.00	1.00	4.00
Dutifulness	4.22	0.40	4.00	3.00	5.00
Assertiveness	4.10	0.56	4.00	2.00	5.00
Excitement-Seeking	4.31	0.42	4.00	3.00	5.00
Adventure	3.88	0.54	4.00	2.00	5.00
Anxiety	3.14	0.68	3.33	1.33	5.00
Dependent Variables					
Share Invested	0.34	0.32	0.20	0.00	1.00
Total Investment	13,906.07	11,821.08	11,350.00	0.00	88,000.00
Credit Desired	14,057.14	12,758.11	10,000.00	0.00	100,000.00
Credit Obtained	5,904.16	12,932.50	0.00	0.00	80,000.00
Controls					
Age	33.64	9.94	32.00	15.00	70.00
Male	0.08	0.27	0.00	0.00	1.00
Education	9.15	3.20	8.00	0.00	16.00
Children	1.75	1.18	2.00	0.00	7.00
Household Size	5.31	1.68	2.00	0.00	1.00
Asset Index	0.01	0.85	-0.23	-0.99	2.34
Food Insecurity Index	-0.14	0.77	-0.09	-1.44	2.24
Average Income	284.02	429.08	150.00	0.00	3,500.00
Pest Likelihood	0.67	0.47	1.00	0.00	1.00
Farmland (acres)	2.38	2.33	1.50	0.00	15.00

Table 2.13: Correlation between traits

	Ag	Ex	Ne	In	Co
Agreeableness	1				
Extroversion	0.3453	1			
Neuroticism	-0.2309	-0.1499	1		
Intellect	0.4554	0.3553	-0.2518	1	
Conscientiousness	0.3877	0.3646	-0.1613	0.4716	1

Table 2.14: Correlation between facets

	Al	Tr	Cau	Du	Ass	Ex	Ad	An
Altruism	1							
Trust	0.3575	1						
Caution	-0.3926	-0.0831	1					
Dutifulness	0.629	0.3547	-0.3887	1				
Assertiveness	0.5823	0.3557	-0.2922	0.4645	1			
Excitement-Seeking	0.593	0.1935	-0.3194	0.4577	0.4189	1		
Adventure	0.2553	0.2266	0.0137	0.2033	0.216	0.3454	1	
Anxiety	-0.0491	0.0017	0.3092	-0.0938	-0.0613	-0.0805	0.06	1

Table 2.15: Scoring coefficients for the asset factor score

Variable	Scoring coefficient	Description
wheelbarrow	0.25	Is there a wheelbarrow on the farm?
pipe	0.23	Does the farm have a hose pipe?
floor	0.22	Is there flooring in the house on the farm?
water	0.20	Is the farm attached to the water grid?
tank	0.15	Does the farm have a rain water reservoir/tank?
electricity	0.14	Is the farm attached to the electricity grid?
sprayer	0.13	Does the farm have a knapsack sprayer?
solar	0.08	Does the farm have a solar panel?
car	0.07	Is there a car/motorbike/truck/matatu on the farm?
plough	0.07	Is there a plough on the farm?

Appendix 3 Regression Results Personality Facets

Table 2.16: Regression of personality facets on share invested in risk game

	(1)	(2)	(3)	(4)	(5)	(6)
	Agreeableness	Extroversion	Neuroticism	Intellect	Conscientiousness	All traits
Altruism	-0.025					0.006
	(0.019)					(0.030)
Trust	-0.010					-0.001
	(0.017)					(0.020)
Assertiveness		-0.005				0.018
		(0.022)				(0.025)
Excitement		-0.016				-0.002
		(0.022)				(0.023)
Anxiety			0.006			0.005
			(0.017)			(0.019)
Adventure				0.017		0.032
				(0.024)		(0.026)
Caution					-0.025	-0.028
					(0.020)	(0.023)
Dutifulness					-0.085***	-0.104**
					(0.028)	(0.040)
Age	0.012	0.013	0.012	0.011	0.010	0.006
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)
Age^2	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Male	-0.011	-0.016	-0.005	-0.009	-0.017	-0.016
	(0.074)	(0.075)	(0.076)	(0.074)	(0.073)	(0.076)
Years of education	-0.002	-0.001	-0.000	0.000	-0.003	-0.002
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Number of children	-0.015	-0.014	-0.015	-0.017	-0.019	-0.023
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.017)
Household size	-0.015	-0.014	-0.014	-0.014	-0.021	-0.021
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)
Food insecurity index	0.047*	0.050*	0.053**	0.055**	0.046*	0.049*
	(0.025)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Asset index	-0.030	-0.031	-0.030	-0.032	-0.029	-0.030*
	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)	(0.017)
Pest likelihood	-0.152***	-0.154***	-0.149***	-0.142***	-0.152***	-0.137**
	(0.049)	(0.050)	(0.049)	(0.050)	(0.051)	(0.056)
Total land farmed	0.014*	0.015*	0.014*	0.015*	0.016**	0.017**
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)
Average income	0.023*	0.023*	0.023*	0.022*	0.022*	0.021*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
Constant	0.197	0.174	0.190	0.198	0.272	0.349*
	(0.180)	(0.175)	(0.173)	(0.179)	(0.192)	(0.205)
Observations	237	237	237	237	237	237
R-squared	0.11	0.11	0.11	0.11	0.15	0.17

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 2.17: Regression of personality facets on investment

	(1) Agreeableness	(2) Extroversion	(3) Neuroticism	(4) Intellect	(5) Conscientiousness	(6) All traits
Altruism	1314.168*					371.409
	(711.182)					(971.827)
Trust	-1439.098**					-1408.933***
	(541.236)					(488.047)
Assertiveness		-554.932				-640.465
		(520.942)				(455.346)
Excitement		1261.986*				871.101
		(652.472)				(645.967)
Anxiety			690.910			1088.324*
			(583.730)			(598.147)
Adventure				-239.032		-451.693
				(401.392)		(404.612)
Caution					-709.039	-787.610
					(645.590)	(737.134)
Dutifulness					768.858	1171.805
					(624.450)	(811.776)
Age	1014.939***	996.857***	919.324**	970.649***	1003.901***	1088.884***
	(352.668)	(345.845)	(379.324)	(352.542)	(338.447)	(362.972)
Age^2	-14.714***	-14.466***	-13.546***	-14.147***	-14.607***	-15.670***
	(4.575)	(4.508)	(4.867)	(4.580)	(4.456)	(4.636)
Male	5653.734*	5898.756*	5824.085*	5298.684	5304.886	6781.420*
	(3315.527)	(3478.163)	(3330.677)	(3399.719)	(3418.837)	(3425.189)
Years of education	6.648	65.193	91.238	54.030	68.830	22.970
	(176.800)	(168.656)	(187.686)	(185.426)	(178.348)	(166.983)
Number of children	-158.699	-267.363	-166.028	-192.232	-188.013	-32.050
	(542.592)	(514.032)	(548.373)	(518.735)	(506.261)	(565.492)
Household size	-360.581	-403.527	-410.997	-372.337	-329.101	-425.485
	(281.519)	(292.284)	(320.152)	(306.644)	(292.223)	(292.626)
Food insecurity index	1785.369**	1718.650*	1564.058*	1565.635*	1764.228*	1809.416**
	(835.344)	(909.196)	(891.869)	(881.785)	(890.903)	(867.387)
Asset index	3109.880***	3044.286***	3148.183***	3050.150***	2952.530***	3236.740***
	(1040.452)	(1005.750)	(1040.302)	(1000.799)	(996.126)	(1043.688)
Pest likelihood	511.363	1055.350	790.718	729.031	588.542	121.679
	(1402.316)	(1456.371)	(1501.989)	(1454.451)	(1467.283)	(1525.355)
Total land farmed	2569.007***	2564.488***	2526.522***	2532.785***	2506.498***	2528.220***
	(603.384)	(594.730)	(616.880)	(616.224)	(604.656)	(601.921)
Average income	1217.567***	1197.542***	1189.968***	1206.536***	1226.005***	1245.943***
	(393.101)	(426.829)	(413.021)	(423.855)	(428.835)	(385.857)
Constant	-13263.330**	-13197.504**	-11845.234*	-12746.511**	-13700.401**	-14510.381**
	(6036.527)	(6051.016)	(6796.960)	(6182.728)	(5657.965)	(6263.736)
Observations	237	237	237	237	237	237
R-squared	0.47	0.46	0.45	0.45	0.46	0.48

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 2.18: Regression of personality facets on amount of desired credit

	(1) Agreeableness	(2) Extroversion	(3) Neuroticism	(4) Intellect	(5) Conscientiousness	(6) All traits
Altruism	371.522					-953.164
	(1105.466)					(1196.767)
Trust	-681.621					-1147.785
	(656.678)					(728.359)
Assertiveness		1284.576				2022.420*
		(813.441)				(1129.904)
Excitement		-28.372				202.056
		(1035.881)				(920.162)
Anxiety			-9.506			-106.152
			(690.808)			(679.166)
Adventure				629.132		559.659
				(896.610)		(834.487)
Caution					545.961	759.322
					(956.557)	(1071.621)
Dutifulness					669.407	677.504
					(983.585)	(1052.808)
Age	-841.790	-981.177	-865.352	-908.240	-865.388	-1076.541
	(848.732)	(875.252)	(858.659)	(862.964)	(873.965)	(915.889)
Age^2	10.128	11.696	10.415	10.940	10.349	12.795
	(10.814)	(10.962)	(10.925)	(10.952)	(11.050)	(11.284)
Male	5348.022	5068.835	5205.252	5243.722	5297.844	5201.814
	(3224.258)	(3226.660)	(3286.985)	(3192.681)	(3156.748)	(3585.341)
Years of education	740.497**	791.464**	771.375**	800.433**	796.550**	779.460**
	(365.635)	(389.983)	(368.385)	(368.206)	(380.538)	(374.683)
Number of children	406.961	311.862	376.905	334.222	410.494	334.122
	(1125.841)	(1119.853)	(1090.890)	(1132.232)	(1124.697)	(1179.129)
Household size	114.382	196.690	117.156	122.977	175.266	272.968
	(435.887)	(465.598)	(436.166)	(450.325)	(434.150)	(438.050)
Food insecurity index	114.030	213.376	72.527	130.028	88.642	123.910
	(1081.017)	(1078.620)	(1141.123)	(1108.034)	(1107.920)	(1123.401)
Asset index	1428.121	1355.516	1386.057	1350.818	1396.246	1412.806
	(1287.469)	(1265.832)	(1259.884)	(1273.065)	(1292.766)	(1268.538)
Pest likelihood	754.447	1166.242	907.873	1140.357	1029.195	1466.927
	(1720.553)	(1624.492)	(1757.640)	(1591.902)	(1699.025)	(1625.092)
Total land farmed	1581.399**	1521.461**	1569.791**	1572.842**	1557.547**	1478.457**
	(696.212)	(693.635)	(688.920)	(693.496)	(688.260)	(702.123)
Average income	423.856	403.010	416.297	399.036	414.860	383.731
	(443.851)	(448.290)	(457.486)	(444.595)	(454.120)	(417.939)
Constant	14504.759	16521.077	14700.185	15248.464	14139.764	17974.739
	(13549.854)	(13638.681)	(13625.524)	(13516.502)	(13612.113)	(14565.309)
Observations	237	237	237	237	237	237
R-squared	0.22	0.23	0.22	0.22	0.22	0.24

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 2.19: Regression of personality facets on amount of desired credit obtained

	(1) Agreeableness	(2) Extroversion	(3) Neuroticism	(4) Intellect	(5) Conscientiousness	(6) All traits
Altruism	1066.443					-437.677
	(889.154)					(831.000)
Trust	1005.105					1198.309*
	(630.579)					(695.143)
Assertiveness		1021.459				725.339
		(731.892)				(600.393)
Excitement		1503.018*				1663.861*
		(791.450)				(870.492)
Anxiety			895.708			1636.549**
			(669.986)			(752.955)
Adventure				405.622		-242.539
				(1014.753)		(907.057)
Caution					-2000.336**	-2251.706**
					(779.586)	(850.509)
Dutifulness					315.534	-1045.683
					(945.745)	(1082.320)
Age	196.454	101.678	156.907	175.220	285.312	72.362
	(417.237)	(398.470)	(403.541)	(447.640)	(457.024)	(430.875)
Age^2	-1.255	-0.186	-0.718	-0.907	-2.248	0.245
	(5.577)	(5.341)	(5.426)	(5.954)	(6.045)	(5.861)
Male	5654.784	6210.605	6348.075	5702.652	5547.048	7054.786*
	(3982.544)	(4114.458)	(3937.855)	(4003.242)	(4050.364)	(4044.438)
Years of education	576.793*	533.752*	541.447*	525.846	477.471	575.060
	(338.121)	(313.462)	(300.528)	(321.134)	(329.054)	(364.177)
Number of children	-1223.956	-1301.632	-1087.906	-1171.087	-1156.776	-1305.957
	(864.734)	(894.742)	(862.882)	(892.219)	(864.924)	(791.386)
Household size	177.830	196.835	78.673	136.055	114.676	-31.205
	(534.104)	(515.604)	(523.524)	(530.449)	(526.348)	(518.670)
Food insecurity index	3073.954**	3148.787**	2771.587**	2839.394**	3076.405**	3172.344**
	(1207.717)	(1208.420)	(1124.779)	(1161.883)	(1189.783)	(1220.880)
Asset index	951.175	1014.505	1192.243	1023.321	892.988	1113.141
	(1240.985)	(1200.491)	(1175.984)	(1187.769)	(1193.132)	(1212.629)
Pest likelihood	2380.154	2735.159*	2067.903	2252.752	1536.931	2265.336
	(1450.080)	(1574.956)	(1563.245)	(1518.610)	(1476.204)	(1680.087)
Total land farmed	-740.074	-780.730	-763.859	-752.153	-782.788	-798.918*
	(463.278)	(473.051)	(464.782)	(470.591)	(492.142)	(448.233)
Average income	901.601**	888.613**	895.996**	898.001**	954.840**	891.177**
	(424.204)	(432.142)	(432.913)	(443.492)	(436.330)	(432.357)
Constant	-7728.951	-5556.602	-6248.617	-6804.394	-8271.802	-3910.233
	(8909.884)	(8591.037)	(8665.094)	(9191.434)	(9562.968)	(8838.125)
Observations	237	237	237	237	237	237
R-squared	0.14	0.15	0.13	0.13	0.15	0.18

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Appendix 4 Discussion of Personality Data

A close look at the psychometric properties of the personality data for the whole sample reveals problems with data quality. From experiences in developed countries, one would expect factor analysis of the 25 questions measuring the Big Five traits to replicate the five-factor structure, with items belonging to the same trait loading on the same factor. Note that the factor analysis is confirmatory in nature – we seek to confirm a five-factor structure based on prior validation studies for the instrument, with items associated with each trait clustering on the appropriate factors. Moreover, both trait and facet subscales should have high internal consistency, with Cronbach's alpha typically greater than 0.70 (Maples et al. 2014). As we'll see in the following tables, the data for the whole sample does not measure up to this standard. We address these problems in two ways. First, we exclude certain facets from the analysis that do not pass minimal standards for psychometric adequacy. Second, we restrict the sample to respondents aged 34 or younger, or respondents with more than eleven years of formal education. Comparing the psychometric properties of personality traits of the whole sample with this subgroup reveals that data quality is higher for the subgroup and passes critical thresholds. This section explains our decisions in depth.

Personality Traits

First, we analyse the 25 items assessing the five personality traits: agreeableness, conscientiousness, extroversion, intellect, and neuroticism. Table 2.20 shows the result of a confirmatory factor analysis for all items. We impose the extraction of five factors, as suggested by the model. Without this constraint, parallel analysis suggests the extraction of eleven factors. We have used an oblique oblimin factor rotation method, to allow for correlation between factors, as is standard in the literature (DeVellis 2016).

Table 2.20: Factor analysis Big Five traits all items

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
A1	0.65				
A2	0.67				
A3		0.48			
A4		0.36			-0.39
C1	0.28	-0.26			
C2	0.51				
C3				0.35	
C4				0.49	
C5				0.32	
E1	0.25	-0.31			
E2	0.29	-0.24			
E3					
E4					0.24
I1			0.54		
I2	0.34	-0.23			
I3		-0.33			
I4					0.59
I5					0.52
I6			0.62		
I7		-0.22	-0.44		
I8					0.64
N1				-0.44	
N2				-0.45	
N3	-0.23	0.31			
N4	-0.21	0.29			

Blanks represent abs(loading)<.2

The results in Table 2.20 show an almost erratic factor structure. Items load positively on several factors, and items belonging to a common trait load on various factors.

What is striking is that the analysis does not show negative loadings for the negatively keyed items, whose scoring we have not reversed here. As Table 2.9 shows, except for intellect, the first two items pertaining to each trait are positively keyed, the others negatively; in the case of intellect, the first three items are positively keyed. This suggests removing the negatively keyed items from the analysis, to test the hypothesis that these items have caused confusion.

Table 2.21 shows the results of a factor analysis focussing exclusively on the positively keyed items, again using an oblique oblimin rotation. This time, parallel analysis suggests a five-factor solution.

Table 2.21: Factor analysis big Five traits all positively keyed items

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
A1	0.63				
A2	0.62				
C1		0.24			
C2	0.50				
E1		0.44			
E2		0.51			
I1					
I2					
I3		0.43			
N1					0.41
N2					0.37

Blanks represent abs(loading)<.2

The results from this factor analysis are already more in line with expectations for three traits: agreeableness, extroversion, and neuroticism. However, none of the items cluster on factors three and four, and items pertaining to conscientiousness and intellect cluster on the wrong factor.

There are three potential reasons explaining the remaining problems with the factor analysis. First, the *instrument* we used might be faulty, i.e., the items we use may not tap into their respective personality traits. Given the extensive research on the item pool we draw on, it is reasonable to assume that the items are at least valid in a developed country context. But perhaps the items are unsuitable to a developing country context. Second, the *translation* we made may have obscured the item's meanings. Third, *participants* may have misunderstood the nature of the test or for other reasons not have provided answers to the items reflecting their personality.

Insofar as instrument and translation error are at play, one would expect problems with the factor structure to persist among subgroups in the sample. By contrast, insofar as a lack of familiarity with personality tests or understanding of the questions is at issue, one would expect problems with the factor structure to diminish in better educated and younger participants, who are more likely to be familiar and at ease with personality tests.

To test which kind of error is at play, we singled out a subsample that we suspect to be particularly likely to grasp the personality test. The subsample is composed of all participants below the age of 35 (N=167), and of participants above the age of 35 if they have more than 10 years of education (N=78).

Limiting the analysis to the subsample improves the factor structure of the traits once again, as shown in Table 2.22. The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.81, a meritorious value (Kaiser 1974). The main remaining issue is that two of the items pertaining to intellect load on factor 2, the factor associated with conscientiousness.

Table 2.22: Factor analysis big Five traits all positively keyed items for subsample

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
A1	0.64				
A2	0.67				
C1		0.52			
C2	0.33	0.31			
E1			0.50		
E2			0.46		
I1				0.37	
I2		0.23			
I3		0.44			
N1					0.43
N2					0.37

Blanks represent abs(loading)<.2

Table 2.23 shows that the subsample is similar to the overall sample in terms of their median household size, the size of their farm land, and the size of their production of maize and beans (cp. Table 2.1). There is only a very small gender effect: 92% of respondents are female (91% in whole sample).

Table 2.23: Descriptive statistics for subsample with age below 35 or more than 10 years of schooling

Variable	Mean	Median	SD	Min	Max
Age	33.6	32.0	9.9	15	70
Household size	5.3	5.0	1.7	2	15
Years of Education	9.2	8.0	3.2	0	16
Total Land (Acres)	2.4	1.5	2.3	0	15
Average Income from Farming/yr (K. Sh)	28,402	15,000	42,908.5	0	350,000
Maize production (kg)	210	90	324.7	0	2,000
Sorghum production (kg)	14	0	76.3	0	800
Soy production (kg)	1	0	9.6	0	90
Sunflower production (kg)	2	0	9.3	0	90
Bean production (kg)	69	20	121.6	0	900
Observations: 245					

Table 2.24 shows Cronbach's alphas and the average inter-item correlations for the five personality traits, both for the full sample and for the subsample. Alphas below 0.6 are usually deemed insufficient in psychometric research (DeVellis 2016). Only the agreeableness items meet this threshold. However, we should note that Cronbach's alpha tends to be lower for scales with fewer items. The alphas on our construct are achieved with only two, or, in the case of intellect, three items. For short scales, an alternative test is to look at average inter-item correlations directly. In general, psychometricians prefer scales with an average inter-item correlation above 0.3, but values as low as 0.2 are accepted in practice (DeVellis 2016). For the whole sample, only agreeableness meets the strict criterion. However, all other scales have average inter-item correlations of between 0.2 and 0.3. In the high understanding subsample, agreeableness, extroversion, and conscientiousness meet the 0.3 threshold, with neuroticism and intellect still above 0.2.

Table 2.24: Cronbach's Alphas and average inter-item correlations for personality traits for full sample and sample with high understanding

	Full sample		Subsample with high understanding	
	Cronbach's Alpha	Average inter-item correlation	Cronbach's Alpha	Average inter-item correlation
Agreeableness	0.63	0.46	0.71	0.56
Extroversion	0.45	0.29	0.52	0.35
Neuroticism	0.36	0.22	0.39	0.24
Intellect	0.46	0.22	0.44	0.21
Conscientiousness	0.41	0.25	0.49	0.32

In sum, factor analysis of the 25 items in the subsample measuring the Big Five traits suggests that the positively keyed items measuring agreeableness, extroversion, neuroticism and conscientiousness measure distinct constructs for the selected subsample. These results warrant using these four traits in further analysis. Two of the three items measuring intellect load on the wrong factor. However, the factor analysis is close enough to expectations to warrant further analysis of all traits. Concerning internal consistency, inter-item correlations are high enough to merit further analysis of all traits in the subsample. Based on these results, we have decided to focus on the selected subsample including all traits, focussing on the positively keyed items, in further analysis. In interpreting results, however, it is important to keep in mind that some items, particularly those pertaining to intellect, may have failed to appropriately tap into their respective personality traits.

Personality Facets

We turn to the subscales measuring specific facets. As Table 2.25 shows, the internal consistency of the subscales as measured by Cronbach's alpha is below the cut-off point of 0.6 for a number of facets.

Table 2.25: Alphas for facet subscales

Facet	Trait	Alpha subsample	Use for further analysis
Altruism	Agreeableness	0.57	
Altruism only Al1-Al3	Agreeableness	0.63	yes
Morality	Agreeableness	0.34	
Trust	Agreeableness	0.58	
Trust T1-T3	Agreeableness	0.63	yes
Caution	Conscientiousness	0.63	yes
Dutifulness	Conscientiousness	0.37	
Dutifulness only Du1-Du2	Conscientiousness	0.43	yes
Motivation	Conscientiousness	0.40	
Self-consciousness	Conscientiousness	0.33	
Assertiveness	Extroversion	0.74	
Assertiveness without As4	Extroversion	0.82	yes
Excitement Seeking	Extroversion	0.46	
Ex. S. only Ex1 and Ex3	Extroversion	0.60	yes
Adventure	Intellect	0.59	yes
Anxiety	Neuroticism	0.45	
Anxiety without An2	Neuroticism	0.59	yes
Average		0.54	

Considering only the full subscales, the mean alpha is 0.54, well below the value of 0.64 found in the validation study of the instrument (Johnson 2014). In the validation study, the lowest alpha is 0.47, for dutifulness. All other alphas are well above 0.6. By contrast, in our sample only assertiveness, caution, and altruism (excluding the negatively keyed item) exceed the threshold of 0.6 in the full sample. This suggests that some of the items may not have been properly understood by participants. For this reason, we remove items from the subscales with suspiciously low item-rest correlations. This approach suggests excluding one item for the facets altruism, anxiety, assertiveness, and trust, as well as two items for dutifulness and excitement seeking.

For a number of the shortened subscales, internal consistency increases to tolerable levels once we consider the high understanding subsample. The subscales that particularly benefit are trust, excitement seeking, and anxiety. For three facets, none of the methods described suffices to

yield subscales with alphas above 0.4. The problematic facets are morality, motivation, and self-consciousness. We have excluded these subscales from further analysis.

Appendix 5 Robustness Analysis subsample

In this section, we present the regression results for varying subsamples to show the robustness of the results reported in the main section of the text. In each of the regression tables, Column 1 repeats the full regression from the main text for the subsample of participants younger than 35 or with more than 11 years of education. All other columns report results from models running the same regression for alternative subsamples. Column 2 includes all participants from the sample. It is noteworthy that with the exception of agreeableness in the second regression, all significant associations between personality traits and outcome variables turn insignificant for the whole sample, although the sign stays constant in all cases. This result supports the assumption that data quality is low in the whole sample. Column 3 differs from column 1 in that we consider a more restricted age group, focussing on participants younger than 32 rather than younger than 34. With few exceptions, the results from this model are qualitatively the same as in the main regressions, in that the same personality traits remain significant without other personality traits becoming significant. An exception is that agreeableness turns insignificant in the first regression. The robustness of the qualitative results show that our findings are not a mere fluke of the exact specification of the subgroup. Column 4 reports results for a slightly larger age group with participants up to 40 years old. With the exception of agreeableness in the third regression, which turns insignificant, the results are qualitatively the same. This result is in line with expectations: while the sign and even significance levels for most results do not change, some results are obscured by the lower data quality for older participants. Column 5 considers only the small group of respondents with more than 11 years of schooling (N=76). All but three results from the high understanding sample can be replicated with this small group alone. The exceptions are agreeableness in the first, second and third regression, which turn insignificant. Overall, we find that our qualitative results are quite robust for different specifications of the subsample.

Personality and risk propensity

Table 2.26: Regression of personality traits on share invested in risk game for different subsamples

	(1) High understanding sample	(2) All participants	(3) Participants < 32 years or > 11 years of education	(4) Participants < 40 years or > 11 years of education	(5) Participants with > 11 years of education
Agreeableness	0.054**	0.008	0.052	0.040*	0.070
	(0.024)	(0.014)	(0.032)	(0.023)	(0.049)
Extroversion	-0.012	0.007	-0.019	-0.007	-0.055
	(0.020)	(0.013)	(0.021)	(0.015)	(0.049)
Neuroticism	0.004	0.016	-0.002	0.007	0.026
	(0.025)	(0.011)	(0.028)	(0.022)	(0.042)
Intellect	-0.063***	-0.005	-0.073***	-0.039*	-0.096***
	(0.022)	(0.015)	(0.025)	(0.021)	(0.031)
Conscientiousness	-0.025	-0.017	-0.023	-0.030*	0.041
	(0.024)	(0.015)	(0.028)	(0.016)	(0.029)
Age	0.007	-0.006	-0.002	0.003	-0.004
	(0.010)	(0.005)	(0.010)	(0.009)	(0.018)
Age^2	-0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Male	0.006	0.059	-0.082	0.080	-0.021
	(0.075)	(0.068)	(0.102)	(0.084)	(0.121)
Years of education	-0.001	0.003	0.000	0.002	-0.050
	(0.007)	(0.004)	(0.008)	(0.007)	(0.035)
Number of children	-0.009	0.004	-0.021	0.001	0.027
	(0.016)	(0.007)	(0.018)	(0.019)	(0.020)
Household size	-0.019	-0.010	-0.012	-0.017	-0.012
	(0.015)	(0.008)	(0.015)	(0.014)	(0.019)
Food insecurity index	0.053**	0.005	0.063**	0.053**	0.015
	(0.025)	(0.013)	(0.023)	(0.025)	(0.044)
Asset index	-0.026	-0.023	-0.029	0.008	-0.050*
	(0.019)	(0.016)	(0.022)	(0.020)	(0.025)
Pest likelihood	-0.161***	-0.122***	-0.134***	-0.152***	-0.140**
	(0.048)	(0.023)	(0.045)	(0.038)	(0.063)
Total land farmed	0.016**	0.006	0.018**	0.007	0.009
	(0.007)	(0.004)	(0.008)	(0.006)	(0.013)
Average income	0.022*	0.017**	0.039**	0.018	0.055*
	(0.012)	(0.007)	(0.016)	(0.011)	(0.030)
Constant	0.296	0.452***	0.307*	0.390**	0.801
	(0.191)	(0.128)	(0.178)	(0.178)	(0.672)
Observations	237	780	177	315	76
R-squared	0.16	0.059	0.19	0.12	0.26

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 2.27: Regression of personality traits on investment for different subsamples

	(1) High understanding sample	(2) All participants	(3) Participants < 32 years or > 11 years of education	(4) Participants < 40 years or > 11 years of education	(5) Participants with > 11 years of education
Agreeableness	2532.544***	1196.976***	2698.671***	2023.275**	1499.553
	(906.993)	(356.517)	(945.182)	(772.665)	(1397.309)
Extroversion	-208.273	254.690	-729.522	-501.696	101.790
	(555.662)	(434.469)	(574.778)	(547.609)	(1272.299)
Neuroticism	-448.614	-511.570*	-229.854	-717.032	-980.451
	(505.518)	(302.059)	(465.560)	(457.950)	(1158.021)
Intellect	439.605	90.127	414.187	243.110	2455.737*
	(867.550)	(411.077)	(734.393)	(749.854)	(1335.942)
Conscientiousness	-2593.257**	-655.981	-2770.166**	-1602.257**	-4694.837**
	(1076.334)	(453.857)	(1269.926)	(738.597)	(1972.509)
Age	758.940**	35.075	788.780**	715.332**	1710.228***
	(309.307)	(141.799)	(310.417)	(315.841)	(393.964)
Age^2	-11.208***	-1.097	-11.096***	-10.998***	-22.740***
	(3.811)	(1.467)	(3.945)	(3.730)	(4.993)
Male	5122.174	670.728	6551.474*	6659.738*	8625.573**
	(3148.552)	(2002.615)	(3783.491)	(3541.635)	(3779.673)
Years of education	-22.439	72.416	-102.527	82.964	504.271
	(184.331)	(113.085)	(193.837)	(154.537)	(1332.270)
Number of children	-314.491	460.572	-15.013	443.279	-672.196
	(502.406)	(284.377)	(576.947)	(578.550)	(1133.894)
Household size	-411.705	57.863	-722.087**	-294.923	-968.079
	(292.880)	(188.057)	(312.073)	(267.573)	(925.545)
Food insecurity index	2038.022**	1366.723***	1859.117*	1255.685	1577.501
	(908.593)	(436.012)	(1026.969)	(858.123)	(1432.214)
Asset index	2954.491***	2095.320***	2988.172***	2660.757***	3203.830*
	(938.079)	(488.098)	(1097.055)	(864.605)	(1665.580)
Pest likelihood	-54.246	-12.584	148.914	-847.381	-3119.562
	(1301.209)	(722.616)	(1527.934)	(1210.259)	(2392.752)
Total land farmed	2515.896***	2204.570***	2306.080***	2742.980***	3690.388***
	(535.359)	(359.202)	(539.378)	(463.118)	(645.024)
Average income	1055.010**	871.179***	1596.792***	904.854**	-995.669
	(393.426)	(182.794)	(419.297)	(351.220)	(1007.702)
Constant	-6718.052	2714.693	-8286.943	-7605.554	-18682.755
	(5134.472)	(3652.347)	(5108.702)	(6235.499)	(20351.041)
Observations	237	780	177	315	76
R-squared	0.51	0.39	0.53	0.49	0.69

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Personality and desire for credit

Table 2.28: Regression of personality traits on amount of desired credit for different subsamples

	(1) High understanding sample	(2) All participants	(3) Participants < 32 years or > 11 years of education	(4) Participants < 40 years or > 11 years of education	(5) Participants with > 11 years of education
Agreeableness	2112.085**	552.881	2569.052*	1393.644	2682.387
	(1021.861)	(357.236)	(1407.570)	(866.344)	(2126.463)
Extroversion	369.978	-30.850	-218.076	356.594	1691.283
	(947.284)	(433.714)	(1267.656)	(742.467)	(3165.308)
Neuroticism	480.615	2.090	936.144	291.361	2403.001
	(745.521)	(331.976)	(814.343)	(547.247)	(1619.234)
Intellect	-792.839	-284.024	-970.691	-409.266	1294.750
	(989.648)	(347.988)	(1204.049)	(608.339)	(2120.371)
Conscientiousness	-108.199	185.523	703.119	151.588	527.579
	(1028.272)	(463.933)	(1366.461)	(800.493)	(2729.189)
Age	-991.871	164.088	-1339.023	-1088.198	-1118.099
	(820.642)	(180.738)	(996.544)	(824.764)	(1339.957)
Age^2	11.819	-2.194	16.430	15.066	13.719
	(10.565)	(1.806)	(13.053)	(11.556)	(17.450)
Male	5211.686	2719.802*	8466.602**	4421.670*	8243.267*
	(3138.339)	(1422.691)	(3245.971)	(2469.531)	(4339.362)
Years of education	834.875**	456.150***	875.082*	554.258*	4352.479*
	(400.218)	(138.306)	(461.455)	(307.852)	(2420.086)
Number of children	476.719	401.249	1268.120	812.657	1828.393
	(1164.466)	(268.961)	(1314.730)	(813.362)	(2369.260)
Household size	28.779	238.136	-497.369	155.847	-2570.814
	(430.337)	(195.770)	(488.650)	(423.051)	(1518.202)
Food insecurity index	481.761	363.163	-719.304	678.439	-2139.051
	(1099.967)	(541.495)	(1486.073)	(887.830)	(2074.106)
Asset index	1454.374	456.326	2402.207	992.883	3246.837
	(1263.980)	(534.858)	(1525.216)	(1060.309)	(1934.977)
Pest likelihood	764.932	390.298	-578.680	172.679	-2303.353
	(1671.889)	(856.380)	(2009.935)	(1245.099)	(3736.584)
Total land farmed	1676.385**	1280.013***	1730.064**	1817.820***	2242.779***
	(666.077)	(331.744)	(654.634)	(438.705)	(758.234)
Average income	370.549	423.981*	916.127*	435.217	956.947
	(442.174)	(220.847)	(521.838)	(369.745)	(1938.253)
Constant	17326.080	-1102.856	21960.262	18083.070	-17493.546
	(12662.767)	(3945.609)	(15522.622)	(13697.679)	(35940.283)
Observations	237	780	177	315	76
R-squared	0.24	0.20	0.33	0.29	0.47

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 2.29: Regression of personality traits on amount of credit obtained for different subsamples

	(1) High understanding sample	(2) All participants	(3) Participants < 32 years or > 11 years of education	(4) Participants < 40 years or > 11 years of education	(5) Participants with > 11 years of education
Agreeableness	-161.565	-319.128	-1627.727**	-459.985	-1879.973
	(631.221)	(399.455)	(655.251)	(605.396)	(1124.707)
Extroversion	-122.278	-73.954	-509.231	-121.369	-524.078
	(864.037)	(501.445)	(1343.493)	(752.719)	(1716.361)
Neuroticism	941.024	11.047	836.619	548.375	-992.657
	(922.585)	(344.433)	(1115.151)	(856.533)	(2693.806)
Intellect	2216.288**	452.390	3570.646**	1329.473*	4155.008**
	(1086.774)	(404.928)	(1553.910)	(729.841)	(2011.317)
Conscientiousness	560.966	754.839**	1138.592	843.377	910.287
	(740.037)	(353.866)	(903.503)	(583.584)	(1647.993)
Age	330.277	252.180	321.283	98.472	-142.395
	(397.968)	(182.581)	(565.065)	(357.920)	(1141.763)
Age^2	-3.089	-2.530	-3.990	-0.586	3.320
	(5.398)	(1.803)	(7.121)	(5.491)	(12.326)
Male	5289.377	3513.483**	10898.989	7230.406*	12874.020*
	(4009.520)	(1714.317)	(6581.757)	(4183.316)	(7465.174)
Years of education	585.188*	569.694***	522.432	604.171**	-1053.579
	(334.912)	(142.619)	(410.472)	(280.621)	(2135.953)
Number of children	-1314.292	-159.492	-1162.219	-799.642	677.143
	(928.841)	(309.128)	(944.157)	(707.117)	(1713.819)
Household size	238.249	199.986	469.011	427.384	131.062
	(565.324)	(213.002)	(919.281)	(435.758)	(1844.411)
Food insecurity index	3004.026**	2120.112***	1656.446	2324.389**	2783.004
	(1198.107)	(685.696)	(1444.558)	(875.056)	(2478.101)
Asset index	913.710	1863.572***	1750.198	1675.904*	-13.263
	(1181.421)	(587.235)	(1165.064)	(838.620)	(1532.870)
Pest likelihood	2241.545	1237.967	1224.263	1801.039	-752.451
	(1477.755)	(1000.563)	(1602.679)	(1296.489)	(3867.374)
Total land farmed	-687.986	-135.357	-849.193	-753.938**	-1907.209**
	(478.337)	(195.508)	(536.934)	(323.166)	(884.357)
Average income	916.981*	325.627*	611.583	621.377	1361.080
	(474.190)	(184.773)	(567.486)	(380.115)	(1474.104)
Constant	-10416.732	-7330.140	-7705.838	-5846.735	16906.502
	(8587.415)	(4450.419)	(8830.520)	(6804.341)	(34239.689)
Observations	237	780	177	315	76
R-squared	0.15	0.11	0.20	0.14	0.25

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Appendix 6 Robustness Analysis Risk Game

In this section, we test the robustness of the regression result for the risk game by changing the outcome variable. Column 1 repeats the final regression from the main text, using the share invested in the risk game as outcome variable. Column 2 uses a categorical variable that is 0 if people have not invested any money at all, 1 if people invested more than nothing but less than half, and 2 if respondents have invested more than half. In column 3, we use a dummy variable as outcome variable that is 0 if no money was invested, and 1 if any money was invested. The motivation for these alternative outcome variables is that understanding of the risk game rather than personality may have influenced the amount people invest.

Even though the alternative outcome variables in columns 2 and 3 are cruder outcome measures in that they do not make use of some of the available data, the signs of the significant traits agreeableness and neuroticism remain constant. Neuroticism, but not agreeableness, remain significant as well.

Table 2.30: Regression of personality traits on amount of share of money invested / dummy for whether money was invested

	(1)	(2)	(3)
Agreeableness	0.056**	0.072	0.131
	(0.026)	(0.058)	(0.246)
Extroversion	-0.013	0.047	0.084
	(0.021)	(0.045)	(0.192)
Neuroticism	0.005	-0.006	-0.041
	(0.025)	(0.058)	(0.208)
Intellect	-0.061***	-0.166***	-0.506**
	(0.021)	(0.050)	(0.239)
Conscientiousness	-0.025	-0.065	-0.310
	(0.024)	(0.044)	(0.219)
Age	0.007	0.029	0.215*
	(0.010)	(0.027)	(0.116)
Age^2	-0.000	-0.000	-0.002
	(0.000)	(0.000)	(0.002)
Male	0.006	-0.137	-0.519
	(0.075)	(0.189)	(0.822)
Years of education	-0.001	0.014	0.048
	(0.007)	(0.016)	(0.068)
Number of children	-0.009	-0.014	-0.084
	(0.016)	(0.036)	(0.146)
Household size	-0.019	-0.043	-0.201
	(0.015)	(0.032)	(0.122)
Food insecurity index	0.053**	0.108	0.179
	(0.025)	(0.072)	(0.267)
Asset index	-0.026	-0.130**	-0.544**
	(0.019)	(0.058)	(0.218)
Pest likelihood	-0.161***	-0.290***	-0.994**
	(0.048)	(0.098)	(0.417)
Total land farmed	0.016**	0.045**	0.192
	(0.007)	(0.020)	(0.134)
Average income	0.022*	0.054*	0.055
	(0.012)	(0.028)	(0.132)
Constant	0.290	0.580	-1.805
	(0.192)	(0.447)	(1.957)
Observations	237	237	237
(Pseudo) R-Squared	0.16	0.18	0.14

Cluster robust standard errors in parentheses (40). * p < 0.10, ** p < 0.05, *** p < 0.01.

Appendix 7 Robustness analysis

This appendix scrutinizes whether the main results of the paper are robust to different specifications of controls. Table 2.31 shows the main regressions with and without controls. Note that all results that all coefficients that are significant in the version with controls have the same sign in the version without any controls and are of the same order of magnitude. As is to be expected, many results that are significant with controls are not significant in the version without controls. Also note that even without any controls, personality traits explain up to 12% of variability in the outcome variables, in the case of investment decisions.

Table 2.31: Comparison of main regressions with and without controls

	(1)	(2)	(3)	(4)	(5)	(6)
	Share invested risk game		Investment		Credit desired	
Agreeableness	0.0407	0.0565**	1913.9*	2659.5***	1193.4	2217.9**
	(0.0258)	(0.0257)	(1011.5)	(952.5)	(936.0)	(1073.1)
Extroversion	0.000843	-0.0130	645.2	-219.5	851.6	390.0
	(0.0178)	(0.0209)	(887.4)	(585.7)	(1028.4)	(998.6)
Neuroticism	0.00352	0.00453	-1620.0**	-454.3	-999.8	486.7
	(0.0235)	(0.0250)	(672.4)	(511.9)	(832.1)	(755.0)
Intellect	-0.0645**	-0.0613***	1406.3	428.0	166.0	-771.9
	(0.0241)	(0.0214)	(1156.9)	(844.7)	(804.8)	(963.5)
Conscientiousness	-0.0222	-0.0255	-4230.3**	-2602.9**	-1213.4	-108.6
	(0.0240)	(0.0237)	(1588.3)	(1080.3)	(1077.7)	(1032.1)
Age		0.00731		758.9**		-991.9
		(0.00987)		(309.3)		(820.6)
Age^2		-0.0000942		-11.21***		11.82
		(0.000120)		(3.811)		(10.57)
Male		0.00557		5122.2		5211.7
		(0.0747)		(3148.6)		(3138.3)
Years of education		-0.00141		-22.44		834.9**
		(0.00713)		(184.3)		(400.2)
Number of children		-0.00941		-314.5		476.7
		(0.0156)		(502.4)		(1164.5)
Household size		-0.0188		-411.7		28.78
		(0.0150)		(292.9)		(430.3)
Food insecurity index		0.0533**		2038.0**		481.8
		(0.0252)		(908.6)		(1100.0)
Asset index		-0.0259		2954.5***		1454.4
		(0.0186)		(938.1)		(1264.0)
Pest likelihood		-0.161***		-54.25		764.9
		(0.0482)		(1301.2)		(1671.9)
Total land farmed		0.0162**		2515.9***		1676.4**
		(0.00722)		(535.4)		(666.1)
Average income		0.0222*		1055.0**		370.5
		(0.0124)		(393.4)		(442.2)
Constant	0.340***	0.290	13906.1***	-6656.4	14057.1***	17062.4
	(0.0278)	(0.192)	(972.6)	(5103.7)	(1370.0)	(12588.0)
Observations	245	237	245	237	245	237
R-squared	0.045	0.16	0.12	0.51	0.025	0.24

Cluster robust standard errors in parentheses (40). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3 Mortgage Literacy and Mortgage Risks

3.1 Introduction

Buying a flat or house is a common and one of the most consequential financial decisions households face (Campbell and Cocco 2003). In the last decades, innovation and deregulation of mortgage markets have opened up access to mortgages to a bigger share of the population, and increased the complexity of mortgage decisions for households (Gerardi, Rosen, and Willen 2010). Moreover, a number of households makes mistakes in selecting a mortgage (Campbell 2006). If households over-borrow, a spell of unemployment or a rise in interest rates can put a severe strain on their budgets. On a systemic level, mortgage debt has played a key role in triggering and amplifying the financial crisis of 2007/8 (International Monetary Fund 2011). Lusardi and Mitchell suggest more research is needed to study the impact of financial literacy on hitherto underexplored economic outcomes (Lusardi and Mitchell 2014).

We answer Lusardi and Mitchell's call by studying the relationship between mortgage literacy and mortgage risks. We assess how much households know about their mortgages, and the impact of this knowledge on the riskiness of their mortgage. The main contribution of this chapter is to introduce a new measure of mortgage literacy, the Mortgage Literacy Questionnaire. The Mortgage Literacy Questionnaire evaluates the domain-specific knowledge of households about mortgages. Mortgage literacy is an aspect of financial literacy. Traditional measures of financial and debt literacy focus on numeracy skills and the understanding of basic financial concepts (Van Ooijen and Van Rooij 2016; Alessie, Rooij, and Lusardi 2011; Lusardi and Mitchell 2011a; Lusardi and Tufano 2015). But studies of risk attitudes have shown risk-taking behaviour is domain-specific (Dohmen et al. 2011). This raises the question whether financial literacy is domain-specific as well. The Mortgage Literacy Questionnaire captures the domain-specific knowledge people need to make sound decisions in selecting a mortgage and

manage risks associated with their mortgage. This knowledge includes differences between mortgage products, as well as the legal and fiscal implications of different types of mortgages.

We administered the Mortgage Literacy Questionnaire to a representative sample of more than 2,000 Dutch households. We find that mortgage literacy is indeed distinct from basic and advanced financial literacy. A significant group of households is financially literate but mortgage illiterate. We demonstrate that mortgage literacy is associated with lower perceived mortgage risk, and with how well households hedge mortgage risk.

Our results suggest that efforts to promote financial literacy should not be limited to teaching financial numeracy and basic financial concepts. Instead, acquiring detailed knowledge about mortgage products and their legal and fiscal environment matter considerably for financial choices regarding mortgages. These results suggest more emphasis should be placed on these domains of knowledge in financial education.

The chapter is structured as follows. Section 3.2 situates our approach in the literature on financial literacy. Section 3.3 gives an overview of the Dutch mortgage market. Section 3.4 gives an overview of the data. Section 3.5 introduces the Mortgage Literacy Questionnaire and the key dependent variables. Section 3.6 presents regression results. Section 3.7 discusses the strengths and limitations of the current investigation, and points to opportunities for further research.

3.2 Contribution and Related Literature

Research on financial literacy investigates to what extent households have the required knowledge to make good decisions in selecting financial products and managing risks associated with these products (Van Rooij, Lusardi, and Alessie 2011a; Lusardi 2012; Duca and Kumar 2014).

The dominant approach to measuring financial literacy is to ask people a number of questions eliciting their basic numeracy skills as well as their knowledge about finance (Lusardi and Mitchell 2011b). Commonly used questions cover proficiency with respect to interest rates, compounded interest, and the time value of money (Van Rooij, Lusardi, and Alessie 2012). We will refer to these questions as *basic financial literacy questions*. In addition, a further questionnaire covers distinctions between bonds and stocks and the functioning of financial markets (Van Rooij, Lusardi, and Alessie 2012). We will refer to these questions as *advanced financial literacy* questions.

Basic and advanced financial literacy questionnaires have been used in numerous studies (Lusardi and Mitchell 2011b). These studies show robustly that financial literacy is low among households (Lusardi and Mitchell 2014). A study of 1,500 Dutch households is indicative of the broader trend: only 40% of respondents answered all five basic financial literacy questions correctly, and only 5% of respondents answered all 11 advanced financial literacy questions correctly (Van Rooij, Lusardi, and Alessie 2012).

Financial literacy matters because it is strongly associated with financial outcomes. People scoring higher on financial literacy are more likely to build up wealth (Lusardi and Mitchell 2007), manage wealth effectively (Hilgert, Hogarth, and Beverly 2003), invest in the stock market (Van Rooij, Lusardi, and Alessie 2011b), select mutual funds with lower fees (Hastings and Tejeda-Ashton 2008), and plan ahead for retirement (Lusardi and Mitchell 2011a).

We contribute to the financial literacy literature by answering Mitchell and Lusardi's call to address understudied outcome measures by investigating the relationship between financial literacy and mortgage outcomes. There have been relatively few studies looking at household debt to date. One study finds that people with low financial literacy are more likely to take out consumer credit and have larger shares of high cost credit such as payday loans (Disney and Gathergood 2013).

Concerning the link between financial literacy and mortgage outcomes, one study finds that households with higher financial literacy are more likely to opt for interest-only mortgages if they also report lower risk aversion (Cox, Brounen, and Neuteboom 2015). Another study shows that financial literacy does not seem to be correlated with financial advice seeking (Kramer 2016).

Alternative measures of financial literacy emphasising saving and borrowing are the questionnaires developed by Van Ooijen and Van Rooij as well as Gathergood and Weber (Gathergood and Weber 2017; Van Ooijen and Van Rooij 2016). Both measures are very similar to basic financial literacy by focussing on basic numeracy and the ability to apply basic financial concepts. In particular, they test familiarity with interest compounding and the time value of money. The difference to basic financial literacy is that these questionnaires are asked in the context of borrowing and saving decisions. These questions have been used with the Dutch DNB Household panel by Van Ooijen et al. (2014) in the Netherlands. Disney and Gathergood (2013) have administered the questions in panels in the UK. The studies show that people with higher debt literacy tend to avoid high-cost consumer borrowing and banking fees. Van Ooijen et al. study the relationship of debt literacy on mortgage choice explicitly. They find that home owners with higher debt literacy are more likely to take out non-traditional and riskier mortgages. Gathergood and Weber show that higher scores on their measure of mortgage financial literacy are associated with a higher likelihood of choosing an interest-only mortgage (Gathergood and Weber 2017).

What is missing from the existing literature is a measure of mortgage literacy that emphasises the knowledge required to selecting a mortgage and managing risks emerging from mortgages. Our main contribution is to introduce a new measure of mortgage literacy. Mortgage literacy addresses the gap in the literature by focusing on the knowledge relevant to selecting a mortgage and managing risks emerging from mortgages. In particular, we include questions on

legal and fiscal aspects of mortgage borrowing. Including these aspects ties our questionnaire to the Dutch environment, as legal and fiscal implications of different mortgage products differ between jurisdictions. In the following section, we provide some background to the Dutch mortgage market, before describing the results of the mortgage risk questionnaire in detail.

3.3 The Dutch Mortgage Market

In 2015, 56% of Dutch households owned their home (The European Commission 2017, 24f). Middle income households often enter the owner-occupied housing markets at an early age, because the private rental market is small in many areas. This is partly due to a large subsidized social housing sector, which 30% of the Dutch relied on in 2015 (The European Commission 2017), and a generous interest deductibility for mortgages. In the Netherlands, interest payments on mortgages are fully tax deductible for up to 30 years. In effect, many areas in the Netherlands do not offer attractive rental options to middle income households ineligible for social housing. A result of the early entry into the mortgage market is high payment-to-income ratios, because the income of young borrowers tends to be lower than for people more advanced in their careers. 75% of households in our sample have taken out a mortgage at some point in their life.

The sharp fall in house prices in the Netherlands during the financial crisis of 2007/08 of 20% on average had a lasting impact on household finance (Statistics Netherlands (CBS) 2017). In effect of the price drop, in 2015 17.6% of homeowners in the Netherlands had higher mortgages than the current value of their house. Household debt-to-GDP stands at 118%, almost twice as much as the EU-28 average (The European Commission 2017, 25). As a result, the European Systemic Risk board issued a warning to the Netherlands in 2016.

Against this backdrop, it is all the more important that households make informed decisions on whether to take out a mortgage, and how to hedge risks associated with mortgages. In our

analysis, we evaluate to what extent households are in a position to assess and manage mortgage risks, taking the specific legal and fiscal situation of mortgage borrowers in the Netherlands into account.

A couple of features of the Dutch housing market deserve to be mentioned, because they provide the background to the questions in the Mortgage Literacy Questionnaire.

Starting in 2013, the Dutch government has begun putting a number of policies in place to improve the functioning of the owner-occupied housing market. Loan-to-income and loan-to-value ratios have been tightened, requiring house buyers to put up more equity and limiting their mortgage payments to a smaller share of their disposable income (Dutch Authority for the Financial Markets 2017c). In particular, banks are required to limit new mortgages to 104% of the value of the mortgaged property.

Moreover, the government mandated a change in the remuneration regime for mortgage advisors. The most important element of this change is the commission ban (Dutch Authority for the Financial Markets 2017d). Mortgage advisors may no longer accept kickbacks from mortgage providers or charge a mark-up on the interest rate of the mortgage. Instead, customers pay advisors a fee for their service, regardless of whether customers take out a mortgage.

As a result, so-called "execution-only mortgages" have become more widespread (Dutch Authority for the Financial Markets 2017a). Customers save the advice fee, paying instead a much lower execution fee. However, customers are required to select their mortgage terms and do the required paperwork by themselves, without the help of a financial advisor.

The new regulation exempts interest-only mortgages taken out after January 2013 from tax deduction. Mortgage types that qualify for tax benefits now are annuity mortgages and linear mortgages. Annuity mortgages repay the principal over the course of the mortgage contract, keeping monthly payments consisting of interest and repayment stable. Annuity mortgages are

the most common type of new mortgage. Linear mortgages are less commonly chosen. Borrowers who take out a linear mortgage repay a fixed proportion of their remaining loan each month, leading to decreasing payments over time.

Partly due to these regulatory changes, mortgage borrowers in the Netherlands commonly have several types of mortgage on the same property. In our sample, 32% of mortgage borrowers have more than one mortgage on their property.

Fixing mortgage rates is common, with 87% of respondents in our sample having fixed the interest rate of their mortgage. On average, borrowers fix their mortgage rate for 11 years.

A unique feature of the Dutch mortgage market is the National Mortgage Guarantee Scheme, an institution to protect mortgage lenders against losses and protect borrowers from spiralling penalty fees if they cannot meet mortgage payments (National Mortgage Guarantee 2017). While the scheme helps borrowers with mortgage payments in circumstances beyond their control, it does not allow borrowers to keep their house if they consistently cannot meet mortgage payments.

3.4 The Data

We have designed a questionnaire on mortgage literacy, which was fielded in the CentERpanel over two weeks in June 2017. The CentERpanel is an Internet based panel of over 2,000 households administrated by CentERdata at Tilburg University and sponsored by the Dutch Central Bank. The panel is representative of the Dutch population. Questionnaires are administered online. Panel members without internet access receive equipment that enables them to participate through their television. Both the head of the household and any partner aged 20 or above are interviewed. 2,126 people completed the survey (1,746 households). 68% of respondents have a residential mortgage on their property (1,443 respondents).

Our questionnaire is combined with background information from the 2016 Dutch Household Survey (DHS). The DHS is an annual study of Dutch households which collects detailed information on wealth holdings, earnings, socio-demographic information and psychological traits. The DHS consists of six modules. The module on accommodation and mortgages is answered by the household member managing the household finances only. Our final sample consists of the heads of households that could be matched to the accommodation module of the DHS 2016 as well as modules on income and wealth to obtain controls (N=1,174). Note that outcome variables are only available for households that have a mortgage. Hence the analysis is performed only on the part of the population that has a mortgage (N=872).

Table 3.1: Sample size

Sample	Size
All individuals who answered our questionnaire	2,126
Individuals from different households who answered our questionnaire	1,746
Heads of households that matched accommodation data from the DHS 2016	1,174
Of those: has a mortgage	872

Table 3.2 contains the summary statistics of the variables we use in the analysis. In the following subsections, we explore the key variables we use in the regression analysis.

Table 3.2: Summary statistics of variables used in the analysis

Variable	N	Mean	SD	Min	Max
Literacy Scores					
Mortgage Literacy	872	3.65	1.58	0	6
Basic Financial Literacy	872	4.27	0.84	1	5
Advanced Financial Literacy	872	7.07	2.95	0	11
Dependent Variables					
R1: Self-assessed general mortgage risk	872	1.76	0.78	0	4
R2: Self-assessed income risk dummy	872	1.98	0.40	1	3
R3: Self-assessed wealth risk dummy	872	2.01	0.38	1	3
Fixed: Interest rate fixing dummy	562	0.88	0.33	0	1
Duration of fix in years	491	11.72	6.54	1	30
Controls					
Male	872	0.71	0.46	0	1
Age	872	58.60	14.88	27	92
Household Net Income	872	3,060	1,389	0	12,617
Household Wealth	872	56,173	159,000	1	2,870,000
Socio Economic Status	872	3.71	1.02	1	5
School Degree	872	0.33	0.48	0	1
Vocational Degree	872	0.49	0.50	0	1
University Degree	872	0.17	0.37	0	1
Married	872	0.66	0.47	0	1
Divorced	872	0.07	0.25	0	1
Number of Children in Household	872	0.57	0.98	0	5
Self-employed	872	0.05	0.22	0	1
Retired	872	0.37	0.48	0	1
Unemployed	872	0.04	0.20	0	1
Government employee	872	0.09	0.29	0	1
Risk proneness[2]	824	0.05	0.83	-1.22	2.23
OLTV: Original Loan to Value Ratio	487	0.98	0.37	0.13	2
CLTV: Current Loan to Value Ratio	478	0.55	0.35	-0.05	2.61
PTI: Payment to Income Ratio	498	0.19	0.15	0	1.84
Yfix: Year of Mortgage Origination	492	2,010.58	4.79	1,981	2,016

[2] The variable is based on the answers to six questions on attitudes to saving behaviour from the DNB household survey. To arrive at a single measure, I work with a weighted combination of the answers to the six questions, with weights coming from a factor analysis of the six questions.

3.5 Mortgage Literacy

3.5.1 The Mortgage Literacy Questionnaire

The Mortgage Literacy Questionnaire is designed to capture salient differences between different types of mortgages, the understanding of the legal rules and protections pertaining to mortgages, as well as the fiscal implications of mortgages. Since our respondents are from the Netherlands, we tailored the questionnaire to the Dutch situation. Hence some of the questions would need to be adapted to employ the questionnaire in other countries. But the results of this study have implications that extend far beyond the Netherlands. While the questions we ask are specific to the Netherlands, knowledge about mortgage types, tax deductibility, and legal protection in the case of default matter in most jurisdictions. Table 3.3 lists the questions and answer options. Correct answers are marked in bold.

We took inspiration from the knowledge quiz developed by the "Dutch Authority for the Financial Markets" for customers as well as from questionnaires that Dutch banks use with customers to help them decide whether they have the knowledge required to opt for a "execution-only" mortgage (Dutch Authority for the Financial Markets 2017b). We discussed the questions with several experts, aiming at covering different common mortgage products in the Netherlands, as well as legal and fiscal issues that can make a major difference to the financial risks created by mortgages.

Participants' answers to the questions elicit whether respondents are aware of the risks associated with different types of mortgage, as well as whether they are aware of the strategies to manage these risks. Question 1 asks respondents about the advantages of fixing mortgage rates. Fixing mortgage rates is a way of managing potential financial vulnerabilities generated by mortgages, i.e. by hedging the risk of a rise in mortgage rates.

Questions 2 and 3 concern the workings of annuity mortgages. Question 2 asks about the evolution of interest payments for an annuity mortgage, and question 3 about the fiscal implications of annuity mortgages.

Question 4 concerns the evolution of outstanding debt for a household with two mortgages, an annuity and an interest-only mortgage. To answer this question correctly, respondents need to combine their knowledge of the workings of annuity and interest-only mortgages.

Question 5 concerns knowledge about the National Mortgage Guarantee Scheme. We test whether borrowers understand the limitations of the help this institution offers in case borrowers are unable to continue to pay their mortgage rates.

Finally, question 6 concerns the difference between taxable income and the amount by which taxes are reduced.

Table 3.3: Mortgage Literacy Questionnaire

1 What is the advantage of fixing the interest rate of your mortgage for longer? (select all that apply) ***i) You will not run the risk that interest rates go up unexpectedly.*** *ii) A longer fixing period is cheaper over the duration. iii) The interest rate is lower in a long interest period. iv) You repay less each month. v) I don't know.*
2 An annuity mortgage is a mortgage that keeps gross mortgage payments stable over the term of the mortgage. How does the share of interest you pay each month develop over the term of the annuity mortgage? ***i) The share of the interest decreases, and the share of your monthly repayment increases.*** *ii) The share of the interest increases, and the share of your monthly repayment decreases. iii) The share of interest stays stable over the period. v) I don't know.*
3 An annuity mortgage is a mortgage that keeps gross mortgage payments stable over the term of the mortgage. How does the amount that you can deduct from your income tax evolve over the term of the mortgage*?* ***i) You can deduct a higher amount at the beginning of the term.*** *ii) You can deduct a higher amount at the end of the term. iii) The amount you can deduct stays stable during the term. iv) I don't know.*
4 Suppose that you have a mortgage loan that consists of two parts: 1) An annuity mortgage loan part of € 50,000; 2) an interest-only mortgage loan part of € 150,000. You don't make any unscheduled repayments during the term. How big is your outstanding debt at the end of the term of your mortgage? *i) 0 EUR ii) 50.000 EUR iii) 100.000 EUR* ***iv) 150.000 EUR*** *iv) 200.000 EUR v) I don't know.*
5 During the term of the mortgage things can happen that lower your income. Think of disability or unemployment. Does the National Mortgage Guarantee scheme allow you to continue living in your house if you cannot pay the mortgage by yourself? *i) yes* ***ii) no*** *iii) I don't know.*
6 You live in your own house. Last year, you paid EUR 10.000 in interest for your mortgage. Your income tax rate in the relevant bracket is 42%. How much of your mortgage interest payments can you deduct from your taxable income? *i) Less than 4.200 EUR ii) 4.200 EUR* ***iii) 10.000 EUR*** *iv) I don't know.*

How is mortgage literacy conceptually related to financial literacy? Mortgage literate borrowers are financially literate in one specific domain, the domain of mortgages. On the conceptual level, mortgage literacy is therefore an aspect of financial literacy. Since mortgage literacy is an aspect of financial literacy, we expect a positive correlation between our measure of mortgage literacy and existing measures of financial literacy.

However, our measure of mortgage literacy covers financial literacy concerning mortgages in considerably more depth than existing measures of financial literacy. In particular, mortgage

literacy emphasises legal and fiscal issues as well as differences between mortgage types not covered by existing general measures of financial literacy. The interest in developing a new measure of mortgage literacy lies precisely in the fact that people who know about the general financial concepts captured by the basic and advanced financial literacy questionnaires may not always know about the specifics relevant in making mortgage decisions, and vice versa. Therefore, we expect that a sizable group of respondents scores high on financial literacy while scoring low on mortgage literacy, and vice versa.

The regression analysis in section 3.6 focuses on the association between mortgage literacy and perceived mortgage risk, and the management of mortgage risk.

Concerning the relationship between mortgage literacy and perceived mortgage risk, we expect mortgage literate people to be more aware of potential risks associated with their mortgage. We expect that this awareness puts them in a better position to avoid and offset the risks associated with a mortgage. This is in line with the theory by Lusardi and Mitchell, according to which mortgage literacy is a form of human capital (Lusardi and Mitchell 2014). They note that the conventional microeconomic approach to saving and borrowing decisions assumes fully rational and well-informed individuals who are capable of optimizing their spending over their life-cycle, in the light of their preferences, expectations about the evolution of the economic environment, including returns on investment and liquidity constraints. Formulating and executing the required saving and spend-down plans to optimize spending over the life cycle involves complex economic calculations and requires expertise in dealing with financial markets. Mortgage decisions are an important element of a saving plan for many Dutch households. Acquiring the required knowledge comes at a cost. Individuals who acquire the skills and knowledge to make complex financial decisions, including mortgage decisions, can therefore be seen as having a form of human capital that yields returns in the financial planning process.

Mortgage literacy can thus be seen as a form of human capital whose benefit consists in more appropriate mortgage decisions, including the avoidance of excessive risk. Hence, we expect mortgage literate borrowers to report their mortgages to be less risky. There are three channels that are likely to link mortgage literacy with lower mortgage risk. First, mortgage literate borrowers know more about the risks associated with mortgages (Huston 2010). This stock of knowledge will often be directly helpful in avoiding or managing excessive mortgage risks. Moreover, the knowledge covered by the Mortgage Literacy Questionnaire also puts their bearers in a better position to acquire new knowledge relevant to their mortgage choice. Having a basic understanding of mortgage products makes it easier to compare alternative offers along relevant dimensions.

Second, mortgage literate people are more likely to be aware of their knowledge about mortgages and the limitations of that knowledge. Improved self-awareness allows mortgage literate people to avoid mistakes in mortgage decisions. By contrast, people with low mortgage literacy are vulnerable to the "Dunning–Kruger effect," according to which people of low ability tend to overestimate their ability. This effect can be explained by the inability of people with low ability in some domain, such as mortgage literacy, to realize their lack of ability (Kruger and Dunning 1999).

Third, mortgage literate borrowers are likely to be able to deal with mortgage advice more productively. First, they are in a better position to judge the quality of the advice. This involves placing trust in advisors intelligently, by screening out bad advice, and acting on the recommendations of trustworthy advisors (Gaudecker 2015).

For these three reasons, we expect that mortgage literate people are better able to avoid excessively risky mortgage choices that might put their household finances in jeopardy. In particular, we expect people with higher mortgage literacy to report that servicing their mortgage is less threatened by income and wealth shocks.

We expect that the human capital that mortgage literacy affords will make mortgage literate borrowers also more able to manage the risks originating from their mortgages. Specifically, we investigate whether households fix interest rates. Mortgages with fixed rates are *ex ante* more expensive than mortgages with floating rates, as households need to pay creditors for assuming the risk of rate hikes (Badarinza, Campbell, and Ramadorai 2017). At the same time, however, fixing interest rates is an effective means of managing some of the risks originating from a mortgage by hedging the downside risk of rate increases (Campbell 2006). While the added costs of fixing interest rates are transparent for borrowers regardless of how mortgage literate they are, the benefits are more likely to be apparent to mortgage literate borrowers. We therefore expect that mortgage literate people are more likely to fix their interest rates.

3.5.2 Mortgage Literacy and Financial Literacy

Table 3.4 shows the summary statistics for the responses to the Mortgage Literacy Questionnaire. Panel A reports the proportion of correct and incorrect answers for each of the six mortgage literacy questions individually. The share of correct answers ranges between over four fifths for question 1 to just above one quarter for question 6. Question 1 on the benefits of fixing interest rates is answered correctly by 85% of respondents. Questions 2 and 4 on differences between mortgage products receive 70% and 76% correct answers, indicating that about three quarters of respondents understand these differences. The remaining three questions concern the fiscal and legal aspects of mortgages. Question 3 asks about the fiscal implications of annuity mortgages. 67% of respondents answer this question correctly. Less than four out of ten answer question 5 on the National Guarantee Scheme correctly. Only 28% of respondents answered the most difficult question 6 on tax benefits of mortgages correctly.

Panel B looks at the proportion of people who achieved a particular score on the entire questionnaire. Only 9% of respondents answered all six mortgage literacy questions correctly.

These results indicate that many Dutch households have difficulties answering questions about differences between mortgage products, as well as their legal and fiscal implications. These are precisely the aspects of mortgage decisions not covered in established measures of financial literacy.

Table 3.4: Summary Statistics Mortgage Literacy (N=872)

Panel A: Respondents who answered individual questions correctly / incorrectly / don't know

	Questions					
	1	2	3	4	5	6
Correct %	85%	70%	67%	76%	39%	28%
N	738	610	583	664	340	246
Incorrect %	13%	19%	12%	12%	44%	46%
N	118	170	105	103	381	402
Don't know %	2%	11%	12%	12%	17%	26%
N	16	92	105	105	151	224

Panel B: Respondents with respective number of correct answers

	Number of correct answers						
	none	1	2	3	4	5	6
Correct	4%	8%	13%	15%	26%	27%	9%
N	34	69	110	128	223	232	76

We have included the basic and advanced financial literacy questionnaires in our survey to enable comparison with the Mortgage Literacy Questionnaire. Appendix 3 shows the results of the basic and advanced financial literacy surveys, respectively. Our results are very similar to the results collected by Van Rooij et al. (Van Rooij, Lusardi, and Alessie 2011a) in 2011. The share of correct answers ranges from three quarters to nine out of ten for the basic literacy questions, and from three out of ten to eight out of ten for advanced financial literacy. Question four about the time value of money remains the most difficult basic literacy question (68% correct); for advanced literacy, question 11 about what happens to bond prices if interest rates fall remains the most difficult question (31% correct). The share of do not know answers is lower for basic literacy questions (2%-7%) than for advanced literacy questions (9%-38%), consistent with the 2011 data. Similar to six years ago, 48% of respondents answer all five

basic literacy questions correctly. Just 11% of respondents got all advanced literacy questions right. Financial literacy in the Netherlands has not changed in the seven years since 2010.

Comparing the mortgage literacy scores with the financial literacy scores shows that respondents find mortgage literacy questions more difficult than the basic and advanced literacy questionnaires. While only 9% of respondents answered all six mortgage literacy questions correctly, 48% answered all five basic financial literacy questions correctly. 27% answered the first six advanced literacy questions correctly, more than three times as many as in the case of mortgage literacy. Nonetheless, respondents are more confident about their knowledge about mortgages than about advanced financial literacy. On average, 13% say that they don't know the right answer to the mortgage debt literacy questions, in contrast to 19% for advanced financial literacy. The difference between these means is statistically significant ($p=0.00$).

Mortgage literacy is not just a more difficult version of the financial literacy questionnaires. Rather, mortgage literacy gets at a distinct domain of knowledge, which is only moderately correlated with financial literacy scores.[3] The correlations between the three measures are all positive, indicating that mortgage literacy is related to financial literacy. The correlation coefficient between basic financial literacy and mortgage literacy is 0.34. Mortgage literacy is more strongly correlated to advanced financial literacy, with a correlation coefficient of 0.63. It is not surprising that advanced financial literacy is more strongly correlated with mortgage literacy than basic financial literacy, because the former tests knowledge about specific financial products such as stocks and bonds, whereas the latter focuses on numeracy. The Mortgage Literacy Questionnaire emphasises knowledge about specific financial products as well, albeit with a focus on mortgages, rather than investment products.

[3] Correlations between the literacy scores are reported in Appendix 2.

Nonetheless, the correlation between mortgage literacy and advanced financial literacy implies that advanced financial literacy captures just 40% of the variance in mortgage literacy. Hence 60% of variance in mortgage literacy is unaccounted for by advanced financial literacy. 35% of respondents (N=282) are in matching quintiles for advanced literacy and mortgage literacy. This leaves almost two thirds of respondents who score in a higher or lower quintile for mortgage literacy than for advanced financial literacy. 11% of respondents (N=96) score in the lowest two quintiles for financial literacy and the highest two quintiles for mortgage literacy or vice versa. These results support the assumption that mortgage literacy measures a distinct construct from financial literacy.

3.5.3 Mortgage Risks

We included three questions to measure whether respondents perceive their mortgage as being risky. The first question asks about whether respondents perceive having a mortgage as a financial risk for them in general. The second question asks whether becoming unemployed would put servicing the mortgage in jeopardy. The third question asks whether a drop in housing prices would put pressure on the financial planning of the household. These questions follow a similar structure to the questions van Ooijen et al. use to measure perceived mortgage risk (Van Ooijen and Van Rooij 2016). 0 reports the wording of the questions and gives an overview of the results. Note that we gathered only 872 responses to these questions because we only asked respondents who have a mortgage.

The results show that 14% of respondents think that taking out a mortgage is a very high or a high-risk decision (R1). By contrast, more than a third consider taking out a mortgage to be no risk at all.

Almost one in ten respondents believe that six months of unemployment would cause difficulties with servicing their mortgage (8% don’t know) (R2).

Almost 7% believe that a 20% price drop in the value of their house would cause them financial distress (8% don't know) (R3). Our results seem to be lower than the results reported by Van Ooijen et al. with respect to related questions administered to the same panel (2016, 11). Their study found that almost two thirds of respondents expect to run into problems with repaying their mortgage in case of an adverse income shock. They find that a quarter of respondents are convinced that a drop in housing prices would lead to serious financial problems. However, we cannot directly compare results because the authors do not report the exact wording of the questions they posed in the study.

3.5.4 Loan-to-value and Payment-to-income ratios

To put perceived mortgage risks into perspective, we include objective measures of mortgage riskiness as controls. We measure objective mortgage riskiness by computing the original loan to value ratio and the payment to income ratio from the household statistics.

Including these objective measures as controls is important because we expect mortgage literacy to have two effects on the perceived riskiness of mortgages running contrary to one another. On the one hand, we expect mortgage literate borrowers to anticipate and manage mortgage risks better. We call this the *cautionary effect* of mortgage literacy. On the other hand, mortgage literate borrowers are more sensitive to the risks associated with their mortgages than less literate borrowers. We call this the *sensitivity effect* of mortgage literacy.

Taking into account loan-to-value and payment-to-income ratios allows us to study the impact of mortgage literacy on perceived mortgage riskiness while controlling for the volume of a mortgage relative to income and equity of the borrower. To the extent that the cautionary effect determines perceived mortgage risks, mortgage literate respondents should tend to report their mortgages to be less risky, because they will have taken steps to manage income and wealth risk, such as fixing interest rates. In contrast, to the extent that the sensitivity effect determines

perceived mortgage risks, mortgage literate borrowers should report their mortgages to be riskier, because they would be more keenly aware of risks.

Following the methodology developed by Van Ooijen et al., and in line with the literature on mortgage defaults, we characterize the riskiness of mortgages in terms of the relationship between the mortgage value and the value of the house (loan-to-value ratio), as well as between monthly mortgage payments and monthly household income (payment-to-income ratio) (Van Ooijen and Van Rooij 2016, 8). High loan-to-value and payment-to-income ratios were a major cause of personal bankruptcy during the financial crisis. In the case of loan-to-value ratios, the reason is that if borrowers have little equity in their house, the amount of their mortgage debt quickly exceeds the value of the house once house prices start to drop (Admati and Hellwig 2013). In the case of payment-to-income ratios, the reason is that unemployment spreads in times of crisis. If payment-to-income ratios are high, even short spells of unemployment or a moderate income drop can force households to sell off their house. Fire-sales concentrated in one region lead to a drop in housing prices, exacerbating existing problems with high loan-to-value ratios.

We calculate the original loan-to-value ratio (OLTV) by dividing the original loan amount by the purchase price of the house. We also calculate the current loan-to-value ratio (CLTV), by dividing the outstanding amount of debt by the current perceived house value. We take into account any savings to pay off the mortgage at the end of the term, for instance in the case of investment mortgages or life insurance mortgages. We calculate the payment-to-income ratio (PTI) by dividing monthly gross mortgage payments by monthly net household income.

As reported in Table 3.5 the mean original loan-to-value ratio is 0.97, suggesting that the average borrower makes a down-payment on their mortgage of just 3%. This implies that if house-prices drop by more than 3% at the beginning of the repayment period, the volume of the mortgage exceeds the value of the house. 45% of borrowers took out a mortgage exceeding

the value of their house. Note that in the Dutch context, paying off the mortgage may still generate a positive return on investment for borrowers, as mortgage payments are subsidized by the government through the tax deductibility of interest paid on mortgages. However, it would be more advantageous for borrowers with negative equity to walk away from their mortgage and buy a house at reduced housing prices with a new mortgage. Unlike in the US, walking away from your mortgage is however not permitted in the Netherlands.

Our findings are consistent with the findings in Van Ooijen et al. In their study, the authors point out a rising trend in OLTV ratios in the period between 2007 and 2010, the last year for which data was available. This period is of course exceptional due to the financial crisis of 2008/9. As illustrated by Figure 3.1 in 0, we see that the presumed trend did not last, as OLTV ratios diminished after 2011. This development is consistent with tightening regulation in the mortgage market in the aftermath of the financial crisis. According to our calculations, 60% of loans in the period from 2007-2010 had an OLTV ratio exceeding 1 (67% according to Van Ooijen et al.'s computations; the difference is probably due to different strategies in cleaning the data). In the period between 2010 and 2016, the share of new mortgages with OLTV ratios above 1 has diminished to 47%.

We find that current Loan-to-Value ratios are 0.56 on average. Van Ooijen et. al find a very similar ratio of 0.55 on average. CLTV ratios of about half of OLTV ratios reflect the fact that many households have paid off parts of their mortgage debt. It is the CLTV ratio that determines at what point a drop in housing values leads to the mortgage exceeding the value of the house. Hence the CLTV ratio is crucial from a financial stability perspective.

Our final measure is the payment-to-income ratio. The PTI ratio is a measure of the payment burden of a mortgage. It expresses what share of their income households spend on housing. While LTV ratios are high by international comparison, PTI ratios are comparatively low at just below 20%. Note that our calculation does not take the full tax deductibility of mortgage

interest payments in the Netherlands into account. Taking the deduction into account would further decrease PTI ratios.

With these measures of the objective riskiness of mortgages in place, we are now in a position to investigate the relationship between perceived mortgage riskiness and objective measures of risk. Table 3.5 shows the perceived mortgage risks relative to the original and current LTV ratios, as well as the current PTI ratios. Answers to R1, the question about general mortgage risks, range from 1 (no risk at all) to 4 (very high risk). The columns for R2 on income risk and R3 on wealth risk report the proportion of respondents in each category who answer the income risk and wealth risk question in the affirmative, respectively. For the current LTV and PTI ratios, the differences between the low, medium, and high quantiles are significant at a 1% level according to Pearson's Chi^2 test. In the case of the original LTV ratio, differences are significant at the 1% level for R2 and R3, but not for R1. For current LTV and PTI, perceived riskiness goes up for respondents with objectively riskier mortgages. This result suggests that respondents with objectively riskier mortgage terms tend to be aware of the increased risks they run. Our findings are consistent with Van Ooijen et. al, who also find that borrowers with objectively riskier mortgages tend to report higher perceived mortgage risks (Van Ooijen and Van Rooij 2016). It appears that borrowers are in general well attuned to the mortgage risks they face.

Table 3.5: Perceived mortgage risks relative to LTV and PTI ratios (N=872)

Original LTV	Mean	R1: Overall Risk	R2: Income Risk	R3: Wealth Risk
Low	0.57	1.66	6.43%	3.51%
Medium	0.99	1.94	12.43%	7.10%
High	1.35	1.86	10.00%	7.65%
Average	0.97	1.82	9.61%	6.08%
Pearson's Chi^2 test		p-value = 0.00	p-value = 0.22	p-value = 0.16

Current LTV	Mean	R1: Overall Risk	R2: Income Risk	R3: Wealth Risk
Low	0.18	1.57	4.73%	0.59%
Medium	0.53	1.70	3.01%	2.41%
High	0.96	2.06	16.56%	12.27%
Average	0.56	1.77	8.03%	5.02%
Pearson's Chi^2 test		p-value = 0.00	p-value = 0.00	p-value = 0.00

Current PTI	Mean	R1: Overall Risk	R2: Income Risk	R3: Wealth Risk
Low	0.06	1.55	2.82%	2.26%
Medium	0.17	1.82	5.71%	5.71%
High	0.35	2.02	19.19%	11.05%
Average	0.19	1.79	9.16%	6.30%
Pearson's Chi^2 test		p-value = 0.00	p-value = 0.00	p-value = 0.00

Note: Mean reports the average LTV/PTI value within the respective category. R1 is reported as a mean on a scale from 0 (no risk) to 4 (high risk). R2 and R3 are dummy variables. The percentages indicate the proportion of respondents who reported that they were concerned about income and wealth risk, respectively.

3.6 Results

In this section, we investigate the relationship between mortgage literacy and perceived mortgage risk as well as the management of mortgage risks. We use the following demographic variables as controls: the net household income, household wealth, education, gender, age, family circumstances, professional status, and risk proneness. These standard controls are included in all regressions.

3.6.1 Mortgage Literacy and Perceived Mortgage Risk

Let us first consider how mortgage literacy relates to perceived mortgage risks. Above we distinguished two effects mortgage literacy might have on perceived mortgage risks which run contrary to each other: the cautionary effect and the sensitivity effect. The cautionary effect consists in the mortgage literate being better able to manage the risks from their mortgages.

They should therefore be less vulnerable to income and wealth shocks. In contrast, to the extent that mortgage literate people are more sensitive to mortgage risks without taking action to address these risks, they should perceive their mortgage to be riskier. The empirical question is whether the sensitivity effect or cautionary effect dominates.

By introducing objective measures of mortgage riskiness, we have prepared the ground to test which of these two effects is more pronounced. By controlling for LTV and PTI ratios, we estimate the effect of mortgage literacy on perceived mortgage riskiness abstracting from differences in the size of the mortgage relative to household income or wealth. Given that households have decided they want a mortgage of a certain size relative to their economic potential, we measure to what extent they manage (perceived) mortgage risks.

Table 3.6 reports the results of an OLS regression with the z-score of perceived general mortgage riskiness introduced in section 3.5.3 as outcome variable (R1). We first show the results for mortgage literacy in addition to standard controls (Column 1), add the objective risk measures (Column 2), replace mortgage literacy with basic and advanced financial literacy (Column 3), and finally include mortgage literacy as well as financial literacy scores (Column 4).

Column 1 shows no significant association between mortgage literacy and perceived mortgage risks. Mortgage literacy turns significant at a 10% level with a negative sign once objective risk measures are included. In light of our distinction between sensitivity and caution we can interpret these results as follows: Since the regression in Column 1 does not control for the objective riskiness of mortgages, the sensitivity effect and the cautionary effect may cancel each other out. By contrast, once we control for objective risk measures, the cautionary effect becomes salient. The payment-to-income ratio is significant at a 1% level. The positive coefficient of the PTI indicates that respondents who spend a greater proportion of their income on their mortgage perceive their mortgage to be riskier. The mortgage literacy coefficient

expresses the contribution mortgage literacy makes when objective risk measures are controlled for. An increase in mortgage literacy by one standard deviation is associated with a 11% of a standard deviation decrease in perceived overall mortgage risk. This can be explained by the cautionary effect of mortgage literacy that is now salient: given mortgages with identical LTV and PTI ratios, mortgage literate borrowers will do more to manage the risks of their mortgages, such as fixing interest rates.

The negative coefficient of mortgage literacy stays significant, now at a 5% level, and becomes slightly larger once we additionally include basic and advanced financial literacy scores (Column 4). Neither basic nor advanced financial literacy is significantly related to overall mortgage riskiness in this model (Column 3). This result indicates that mortgage literacy is significantly associated with perceived financial riskiness over and above basic and advanced financial literacy. By contrast, neither basic nor advanced financial literacy is significantly related to differences in perceived mortgage riskiness.

Table 3.6: Regression results: Mortgage literacy and perceived general mortgage risks (R1)

Variables	(1)	(2)	(3)	(4)
Mortgage Literacy	-0.0016	-0.1086*		-0.1228**
	(0.0405)	(0.0571)		(0.0616)
Basic Financial Literacy			-0.0038	0.0050
			(0.0521)	(0.0521)
Advanced Financial Literacy			-0.0055	0.0386
			(0.0607)	(0.0644)
Male	0.0320	0.0030	-0.0015	-0.0133
	(0.0788)	(0.1063)	(0.1100)	(0.1097)
Age (18-34 omitted)				
35-44 years	-0.0636	-0.3113	-0.2907	-0.3153
	(0.1525)	(0.2141)	(0.2159)	(0.2153)
45-54 years	-0.3258**	-0.6200***	-0.6016***	-0.6230***
	(0.1496)	(0.2157)	(0.2176)	(0.2170)
55-64 years	-0.4424***	-0.4758**	-0.4648**	-0.4809**
	(0.1499)	(0.2233)	(0.2257)	(0.2249)
65 years and older	-0.4505**	-0.5663**	-0.5393**	-0.5734**
	(0.1816)	(0.2705)	(0.2730)	(0.2724)
Education (School degree omitted)				
Vocational Education	0.0387	0.1146	0.1466	0.1162
	(0.0843)	(0.1139)	(0.1138)	(0.1143)
University Education	0.1575	0.2430	0.2686	0.2407
	(0.1333)	(0.1650)	(0.1656)	(0.1655)
Log Household Income	-0.0435	0.1842	0.1824	0.1744
	(0.0918)	(0.1448)	(0.1466)	(0.1460)
Log Household Wealth	-0.0278**	-0.0347*	-0.0424**	-0.0361*
	(0.0137)	(0.0206)	(0.0206)	(0.0208)
Socioeconomic Status	0.0348	0.0150	-0.0007	0.0110
	(0.0465)	(0.0611)	(0.0615)	(0.0616)
Married	-0.0478	0.0696	0.0636	0.0717
	(0.0849)	(0.1111)	(0.1118)	(0.1114)
Divorced	0.0548	-0.0954	-0.1089	-0.0952
	(0.1530)	(0.1993)	(0.2005)	(0.1998)
Number of Children in Household	0.0750*	0.0903*	0.0939*	0.0925*
	(0.0426)	(0.0527)	(0.0532)	(0.0530)
Self-employed	0.0593	0.1660	0.1615	0.1776
	(0.1544)	(0.2064)	(0.2085)	(0.2078)
Retired	-0.2099	-0.0931	-0.0877	-0.0894
	(0.1333)	(0.1860)	(0.1874)	(0.1866)
Unemployed	0.1984	0.0758	0.1121	0.0684
	(0.1736)	(0.2286)	(0.2294)	(0.2295)
Government worker	-0.0958	0.0864	0.0971	0.0865
	(0.1145)	(0.1372)	(0.1387)	(0.1382)
Risk proneness	0.1339***	0.1275**	0.1172**	0.1188**
	(0.0421)	(0.0543)	(0.0563)	(0.0561)
Mortgage Characteristics				
OLTV		-0.1107	-0.1163	-0.1112
		(0.1144)	(0.1151)	(0.1147)
CLTV		0.0022	0.0009	0.0066
		(0.1934)	(0.1949)	(0.1941)
PTI		1.5778***	1.5425***	1.5588***
		(0.4662)	(0.4702)	(0.4683)
Constant	0.8254	-1.0414	-0.9684	-0.9274
	(0.7078)	(1.1038)	(1.1259)	(1.1215)
Observations	814	383	383	383
R-squared	0.1226	0.2428	0.2352	0.2436
Adjusted R-squared	0.102	0.196	0.186	0.193

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In Appendix 5, we run a robustness check with perceived income risk (R2) and wealth risk (R3) as dependent variables. The results support the present analysis: increased mortgage literacy is associated with lower perceived mortgage risk. In addition, we run another robustness check that uses only questions 1-4 in the mortgage risk questionnaire. The reason

is that questions five and six were very difficult for most participants. Someone might argue that our results might be driven by these difficult questions. They are not. The robustness check shows that excluding questions five and six leads qualitatively to the same results, with slightly bigger coefficients, rendering mortgage literacy in column 2 significant at the 5% level, rather than only at the 10% level as with the full measure. We ran the remaining regressions below with the shorter measure as well. Again, we find qualitatively the same results. Hence the difficult questions five and six do not drive our results.

3.6.1.1 Addressing Endogeneity

Based on the results from the OLS regressions reported so far, we cannot yet give a causal interpretation of the relationship between mortgage literacy and perceived mortgage risks. Mortgage literacy might be endogenous due to reverse causality, if by managing mortgage risks better one becomes more mortgage literate. Omitted variables are another potential source for endogeneity. We have included a wide range of controls to mitigate omitted variable bias. Nonetheless, we cannot control for the general ability to deal with fiscal and legal issues and to navigate intransparent product markets. As a result, the estimated mortgage literacy coefficient may be biased upwards. By contrast, it is likely that mortgage literacy is measured with substantial error with the short instrument we developed, which may lead to a downward bias in the estimated mortgage literacy coefficient.

To address these concerns about potential upward or downward biases in the mortgage literacy coefficient, we perform an instrumental variable estimation, instrumenting mortgage literacy with financial literacy scores ten years ago. Having general knowledge about personal finance puts people in a better position to acquire more specialized knowledge about finance. Mortgage literacy is a specialized aspect of financial literacy. It is therefore plausible that being financially literate ten years ago is causally linked to being more mortgage literate today. Hence

financial literacy in 2006 is a good candidate to meet the *first stage requirement* on a good instrument.

The regression results reported above suggest that not even present basic and advanced financial literacy scores are significantly associated with perceived mortgage risks. It is therefore hard to see how financial literacy ten years ago should be influenced by perceived mortgage risks today. Financial literacy scores in 2006 therefore seem to meet the *exclusion requirement* on good instruments, making it a promising instrument to rule out reverse causality.

Finally, good instruments are required to be *unrelated to the assumed omitted variables* we want to control for. Financial literacy is likely to be unrelated to the omitted variables we are most concerned about, including the ability to deal with tax and legal issues and the ability to navigate non-transparent product markets. The reason is that financial literacy abstracts from the details of concrete financial products, as well as the legal and tax implications of financial decisions.

Appendix 7 reports the results of a GMM regression using basic and advanced literacy scores in 2006 as instruments for mortgage literacy. The second-stage regression supports our previous analysis. Mortgage literacy is negatively related to perceived mortgage risks, significant at a 1% level. The coefficient is almost ten times as large as in the OLS regression, suggesting that the OLS estimate may be biased downwards. The results of the Wu-Hausman test for endogeneity suggest that mortgage literacy is indeed endogenous ($p = 0.0024$). Hansen's over-identification test suggests that there is indeed no significant correlation between our instrument and the error term ($p = 0.24$).

However, we should treat the results of the IV repression with extreme caution. After merging with the 2006 dataset, only 131 observations survive – a severely diminished sample.

Moreover, financial literacy in 2006 is far from a perfect instrument for mortgage literacy. The F-statistic is well below the recommended cut-off point of 10 to avoid the weak-instrument problem (F = 1.9) (Staiger and Stock 1997). For weak instruments, the coefficients in GMM estimations may be biased in the same direction as the OLS estimate. We should therefore not rest strong conclusions on the IV regression. Mitigating these features somewhat is that repeating the regression with the LIML instead of the GMM estimator leads to qualitatively the same results (mortgage literacy has a coefficient of -2.91, significant at the 10% level). LIML estimators tend to be less biased for weak instruments than GMM estimates. Overall, the instrumental variable approach is consistent with the conclusion that mortgage literacy leads to lower perceived mortgage risks. Because of the flaws of the instrument, however, we cannot derive much additional support from the approach.

It is worth mentioning an alternative explanation for why mortgage literate borrowers report lower perceived mortgage risks. Increased mortgage literacy may somehow be associated with a lower sensitivity for risks associated with a mortgage. This explanation is strongly counter-intuitive, as the Mortgage Literacy Questionnaire tests for knowledge that should improve the awareness of borrowers of mortgage risks. Because of the implausibility of the alternative explanation, we conclude that increased mortgage literacy is associated with lower perceived mortgage risk because mortgage risks for this group are indeed smaller.

We suspect that mortgage risks are smaller for mortgage literate borrowers because they manage risks originating from their mortgage more cautiously. For instance, fixing the interest rate of a mortgage for longer hedges the risk of surging mortgage payments due to interest rate increases. This explanation supports our expectation that increased mortgage literacy is associated with lower mortgage risks. In the next section, we provide further support by showing that mortgage literate borrowers do indeed take additional steps to hedge risks from their mortgages.

3.6.2 Mortgage Literacy and Mortgage Terms

In this section, we test our expectation that increased mortgage literacy is associated with borrowers hedging risks originating from their mortgage. Fixing mortgage interest rates is a way of managing the risk of interest rate hikes. For this reason, we expect that more mortgage literate respondents are more likely to fix their interest rates.

In Table 3.7, we run a probit analysis with the dummy variable whether people fixed their interest rates as dependent variable. We first show results for mortgage literacy as independent variable, in addition to standard controls (Column 1). Second, we replace mortgage literacy by basic and advanced financial literacy (Column 2). Finally, we combine all three literacy measures into one regression (Column 3).

The coefficient of mortgage literacy is positive and significant at the 1% level. This result suggests that more mortgage literate people are more likely to fix their rates, with an increase in mortgage literacy of one standard deviation associated with an increase of 28% of the likelihood of fixing your rate. In contrast, financial literacy is not associated with a significant increase of rate-fixing. If financial and mortgage literacy scores are combined, mortgage literacy stays significant, and financial literacy remains insignificant. Therefore, the significant association of mortgage literacy with rate fixing exists even if we control for financial literacy.

Table 3.7: Regression results: Mortgage Literacy and rate-fixing

Variables	(1)	(2)	(3)
Mortgage Literacy	0.2383***		0.2065**
	(0.0920)		(0.1009)
Basic Financial Literacy		0.0592	0.0302
		(0.0900)	(0.0920)
Advanced Financial Literacy		0.1467	0.0688
		(0.1011)	(0.1093)
Male	-0.0128	-0.0380	-0.0481
	(0.1844)	(0.1879)	(0.1904)
Age (18-34 omitted)			
35-44 years	-0.1038	-0.0706	-0.0922
	(0.4142)	(0.4040)	(0.4129)
45-54 years	-0.1553	-0.1260	-0.1398
	(0.4045)	(0.3972)	(0.4048)
55-64 years	-0.6373	-0.5659	-0.6280
	(0.3939)	(0.3840)	(0.3946)
65 years and older	-0.8363*	-0.7907*	-0.8262*
	(0.4630)	(0.4567)	(0.4645)
Education (School degree omitted)			
Vocational Education	-0.3473*	-0.3915*	-0.3466*
	(0.2054)	(0.2040)	(0.2057)
University Education	-0.5521*	-0.5981**	-0.5521*
	(0.3035)	(0.3007)	(0.3036)
Log Household Income	0.3594*	0.3294	0.3417
	(0.2117)	(0.2125)	(0.2137)
Log Household Wealth	0.0248	0.0260	0.0216
	(0.0300)	(0.0302)	(0.0304)
Socioeconomic Status	0.0767	0.0962	0.0684
	(0.1073)	(0.1070)	(0.1081)
Married	-0.2919	-0.2673	-0.2893
	(0.1942)	(0.1934)	(0.1947)
Divorced	0.0995	0.1502	0.1014
	(0.3887)	(0.3795)	(0.3882)
Number of Children in Household	-0.0426	-0.0475	-0.0429
	(0.1012)	(0.1009)	(0.1013)
Self-employed	-1.0001***	-0.9510***	-0.9849***
	(0.2964)	(0.2978)	(0.2979)
Retired	-0.0609	-0.0756	-0.0592
	(0.3150)	(0.3157)	(0.3164)
Unemployed	-0.6570*	-0.7204**	-0.6787*
	(0.3597)	(0.3570)	(0.3613)
Government worker	-0.2126	-0.2138	-0.2186
	(0.2483)	(0.2487)	(0.2496)
Risk proneness	-0.2701***	-0.2847***	-0.2902***
	(0.0972)	(0.1001)	(0.1010)
Constant	-1.0550	-0.8896	-0.8521
	(1.6217)	(1.6425)	(1.6541)
Observations	533	533	533
Pseudo R-squared	0.113	0.105	0.115

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The first question in the Mortgage Literacy Questionnaire concerns the advantages of fixing mortgage rates. The expected answer is that fixing the interest rate hedges the downside risk of interest rate hikes. Is the regression result driven just by the answer to the first question, or does the Mortgage Literacy Questionnaire as a whole elicit a tendency to manage mortgage risks better? In Appendix 6, we report the results of a robustness analysis to address this issue. We run the above regression with a modified mortgage literacy score, which is only based on answers to questions two to six in the questionnaire, excluding question 1. The results are

qualitatively the same as in the above regression, with the exception that the significance level of mortgage literacy in column 1 decreases to 5%.

For robustness, we run an additional OLS regression with the duration of the interest rate fix as dependent variable (Table 3.8). On average, the 42% of respondents who fixed their interest rates (N=491) fixed rates for 12 years, from a minimum of one year (N=10) to a maximum of 30 years (N=26). Popular choices are five years (N=62), ten years (N=226), and 20 years (N=54). We include as an additional control the year in which the mortgage was fixed, to pick up on trends in inflation expectations and varying practice over time. Column 1 reports results for mortgage literacy, column 2 for financial literacy, and column 3 for both mortgage and financial literacy.

The coefficient of mortgage literacy is positive and significant at a 5% level, suggesting that an increase in mortgage literacy of one standard deviation is associated with an increase in the duration of the interest rate fix of almost three quarters of a year. There is no significant association between financial literacy and the duration of the interest fix. If both mortgage and financial literacy are included, mortgage literacy stays significant, at the 10% level, while financial literacy remains insignificant.

This result supports the finding from the previous analysis: mortgage literacy is associated with an increase not only of whether people fix their mortgage rates, but also with for how long. Financial literacy, however, does not appear to be associated with the duration of the interest rate fix.

Table 3.8: Regression results: Mortgage literacy and duration of interest rate fix

Variables	(1)	(2)	(3)
Mortgage Literacy without Q1	0.6801**		0.6702*
	(0.3350)		(0.3619)
Basic Financial Literacy		0.2856	0.2222
		(0.3396)	(0.3404)
Advanced Financial Literacy		0.1755	-0.0799
		(0.3789)	(0.4023)
Male	-0.7963	-0.7950	-0.8067
	(0.6398)	(0.6613)	(0.6595)
Age (18-34 omitted)			
35-44 years	1.7629	1.8182	1.8113
	(1.1476)	(1.1554)	(1.1522)
45-54 years	0.0763	0.0515	0.1254
	(1.1625)	(1.1708)	(1.1683)
55-64 years	-1.2236	-1.1493	-1.1284
	(1.1807)	(1.1964)	(1.1932)
65 years and older	-1.8086	-1.7729	-1.7321
	(1.5163)	(1.5297)	(1.5257)
Education (School degree omitted)			
Vocational Education	-0.1196	-0.2325	-0.1174
	(0.7221)	(0.7228)	(0.7235)
University Education	0.3816	0.2475	0.3798
	(1.0868)	(1.0894)	(1.0888)
Log Household Income	1.3279	1.3319	1.3090
	(0.9032)	(0.9127)	(0.9102)
Log Household Wealth	-0.0456	-0.0180	-0.0461
	(0.1265)	(0.1272)	(0.1277)
Socioeconomic Status	-0.4979	-0.3856	-0.4943
	(0.4073)	(0.4065)	(0.4096)
Married	0.1206	0.1815	0.1301
	(0.6998)	(0.7025)	(0.7012)
Divorced	0.4600	0.7181	0.4416
	(1.3138)	(1.3116)	(1.3165)
Number of Children in Household	-0.5018	-0.5315	-0.5040
	(0.3316)	(0.3330)	(0.3325)
Self-employed	-3.0205**	-3.1168**	-2.9952**
	(1.2966)	(1.3014)	(1.2995)
Retired	-0.6086	-0.6969	-0.6318
	(1.2051)	(1.2106)	(1.2078)
Unemployed	-0.3832	-0.5186	-0.4550
	(1.6774)	(1.6930)	(1.6888)
Government worker	0.1147	0.0177	0.0795
	(0.8683)	(0.8735)	(0.8717)
Risk proneness	-0.2484	-0.2657	-0.2559
	(0.3501)	(0.3648)	(0.3638)
Year of Mortgage Contract	-0.6332***	-0.6279***	-0.6293***
	(0.0559)	(0.0565)	(0.0564)
Constant	1,277.8977***	1,266.8896***	1,270.2631***
	(112.4391)	(113.7170)	(113.4204)
Observations	464	464	464
R-squared	0.2717	0.2668	0.2724
Adjusted R-squared	0.239	0.232	0.236

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The results from this section lend additional support to the hypothesis that increased mortgage literacy has a cautionary effect on borrowers. This is consistent with the explanation that since mortgage literate borrowers know more about risks that originate from mortgages, they take active steps to hedge these risks, such as fixing their mortgage for longer. The reason that more mortgage literate borrowers perceive their mortgage to be less risky may thus indeed be that

their mortgage risks are in fact lower due to better management of mortgage risks on the part of borrowers.

3.7 Discussion and Conclusion

We introduced the Mortgage Literacy Questionnaire, a new measure of the domain-specific knowledge relevant to mortgage decisions, to study mortgage risks and risk management strategies. We showed that mortgage literacy captures a specific domain of knowledge that is not covered by basic and advanced financial literacy. We have investigated two main questions: first, how much do mortgage borrowers know about different mortgage products, as well as the legal and fiscal implications of their mortgage? Second, is increased mortgage literacy associated with differences in how mortgage risks are perceived and whether they are hedged?

We find that there are considerable shortcomings in the knowledge of Dutch households concerning mortgages. Only 9% of respondents answered all six questions of the Mortgage Literacy Questionnaire correctly. Only a minority understand the National Mortgage Guarantee scheme or the fiscal implications of taking out a mortgage. The three questions concerning legal and fiscal matters were answered correctly by between a quarter and just over half of participants.

We find evidence that mortgage literacy is associated with lower perceived mortgage risk. We considered two reasons for this result: either increased mortgage literacy makes borrowers less sensitive to mortgage risks, or increased mortgage literacy leads to more cautionary management of mortgage risks. The former explanation is highly counterintuitive. We have found additional support for the latter explanation by investigating whether mortgage literacy is associated with a particular strategy to hedge mortgage risks, namely to fix interest rates. We find that mortgage literate borrowers are more likely to fix their mortgage rates, and that they fix their rates for longer. These results suggest that mortgage literacy has a cautionary effect,

leading to better management of mortgage risks and thus to less vulnerability to income and wealth shocks.

It is noteworthy that basic and advanced financial literacy are not significantly associated with either mortgage risks or the management of mortgage risks. This result suggests that mortgage literacy has predictive power concerning mortgage decisions over and above financial literacy.

Our OLS regressions do not exclude the possibility that mortgage literacy arises endogenously with financial choices. If mortgage literacy is correlated with unobserved variables, this could lead to falsely attributing the effects of these unobserved variables to mortgage literacy. We addressed this problem partly by including a large range of controls that could influence the outcome variables and may be correlated with mortgage literacy, including variables capturing household wealth and income as well as socioeconomic status, gender, age, employment, risk proneness, loan-to-value and payment-to-income ratios, and education.

Another potential source of endogeneity is reverse causality. Mortgage literacy might arise from financial behaviour or outcomes, rather than vice versa. For instance, in making particular mortgage decisions, people may gain mortgage literacy (Allgood and Walstad 2016).

Evidence on endogeneity bias in studies examining financial literacy is mixed. Lusardi and Mitchell find that IV approaches tend to show larger effect sizes than OLS regressions, suggesting that OLS regressions tend to underestimate the importance of financial literacy for financial outcomes (Lusardi and Mitchell 2014). By contrast, Fernandes et al. find smaller effects for IV designs than OLS designs (Fernandes, Lynch, and Netemeyer 2014).

Insofar as reverse causality influences our estimates, it likely leads to an underestimation of the effect size of mortgage literacy on our outcome variables. Concerning our first regression, people who perceive their mortgages to be riskier may feel motivated to learn more about mortgages, thereby improving their mortgage literacy. Our OLS regression would tend to

underestimate the negative association of mortgage literacy on perceived mortgage risks. The negative association we find between mortgage literacy and perceived mortgage risks would thus in reality be even larger.

Concerning the second regression, it is difficult to see how rate fixing would lead to improved mortgage literacy. By contrast, borrowers who opt for adjustable-rate mortgages may increase their mortgage literacy as they work through the reasons for changing mortgage payments over the duration of the loan. We find that mortgage literacy increases the likelihood of rate-fixing. Therefore, insofar as reverse causality affects the results, it likely decreases the effect size of mortgage literacy on rate-fixing behaviour.

To further address the endogeneity problem, we take an instrumental variable approach to address reverse causality and remaining omitted variable bias (section 3.6.1) with respect to the regression with perceived mortgage risk as dependent variable (Gathergood and Weber 2017). We find that financial literacy ten years ago meets the criteria of a good instrument. The GMM estimation supports the results from the OLS regression. However, financial literacy ten years ago is only a weak instrument. Based on a conditional likelihood ratio test, we can be confident that there is a negative causal relation between mortgage literacy and perceived mortgage risks.

The main policy implication of this study is that mortgage literacy matters. Mortgage literacy is distinct from financial literacy. Training numeracy and educating people about general financial concepts such as interest rates and the time value of money is insufficient to put them in a good place for selecting a mortgage. Rather, an expanded notion of mortgage literacy, including information about different mortgage products, as well as legal and fiscal aspects of mortgages is needed to equip households to make prudent mortgage choices.

Appendix 1 Questions

Table 3.9: Basic Financial Literacy Questions

#	Question	Answer
B1	Numeracy: Suppose you had €100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?	**(i) More than €102**; (ii) Exactly €102; (iii) Less than €102; (iv) Do not know.
B2	Interest compounding: Suppose you had €100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have in this account in total?	**(i) More than €200**; (ii) Exactly €200; (iii) Less than €200; (iv) Do not know.
B3	Inflation: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?	(i) More than today; (ii) Exactly the same; **(iii) Less than today**; (iv) Do not know.
B4	Time value of money: Assume a friend inherits €10,000 today and his sibling inherits €10,000 3 years from now. Who is richer because of the inheritance?	**(i) My friend**; (ii) His sibling; (iii) They are equally rich; (iv) Do not know.
B5	Money illusion: Suppose that in the year 2010, your income has doubled and prices of all goods have doubled too. In 2010, how much will you be able to buy with your income?	(i) More than today; **(ii) The same**; (iii) Less than today; (iv) Do not know.

Table 3.10: Advanced Financial Literacy Questions

#	Question	Answer
A1	Which of the following statements describes the main function of the stock market?	(i) The stock market helps to predict stock earnings; (ii) The stock market results in an increase in the price of stocks; **(iii) The stock market brings people who want to buy stocks together with those who want to sell stocks;** (iv) None of the above; (v) Do not know.
A2	Which of the following statements is correct? If somebody buys the stock of firm B in the stock market:	**(i) He owns a part of firm B**; (ii) He has lent money to firm B; (iii) He is liable for firm B's debts; (iv) None of the above; (v) Do not know.
A3	Which of the following statements is correct?	(i) Once one invests in a mutual fund, one cannot withdraw the money in the first year; **(ii) Mutual funds can invest in several assets, for example invest in both stocks and bonds**; (iii) Mutual funds pay a guaranteed rate of return which depends on their past performance; (iv) None of the above; (v) Do not know.
A4	Which of the following statements is correct? If somebody buys a bond of firm B	(i) He owns a part of firm B; **(ii) He has lent money to firm B;** (iii) He is liable for firm B's debts; (iv) None of the above; (v) Do not know.
A5	Considering a long time period (for example 10 or 20 years), which asset normally gives the highest return?	(i) Savings accounts; (ii) Bonds; **(iii) Stocks**; (iv) Do not know.
A6	Normally, which asset displays the highest fluctuations over time?	(i) Savings accounts; (ii) Bonds; **(iii) Stocks**; (iv) Do not know.
A7	When an investor spreads his money among different assets, does the risk of losing money	(i) Increase; **(ii) Decrease**; (iii) Stay the same; (iv) Do not know.
A8	If you buy a 10-year bond, it means you cannot sell it after 5 years without incurring a major penalty. True or false?	(i) True; **(ii) False**; (iii) Do not know.
A9	Stocks are normally riskier than bonds. True or false?	**(i) True**; (ii) False; (iii) Do not know.
A10	Buying a company stock usually provides a safer return than a stock mutual fund. True or false?	(i) True; **(ii) False**; (iii) Do not know.
A11	If the interest rate falls, what should happen to bond prices?	**(i) Rise**; (ii) Fall; (iii) Stay the same; (iv) None of the above; (v) Do not know; (vi) Refusal.

Appendix 2 Correlation Matrix

Table 3.11: Correlation matrix of variables used in the analysis (N=872)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1 Mortgage Literacy	1.00																											
2 Basic Financial Literacy	0.34	1.00																										
3 Advanced Financial Literacy	0.63	0.36	1.00																									
4 R1: Self-reported general mortgage risk	0.08	0.07	0.11	1.00																								
5 R2: Self-reported income risk dummy	-0.07	-0.02	-0.08	-0.26	1.00																							
6 R3: Self-reported wealth risk dummy	-0.13	-0.09	-0.14	-0.22	0.29	1.00																						
7 Fixed: Interest rate fixing dummy	0.09	0.03	0.02	0.00	-0.04	-0.05	1.00																					
8 Duration of fix in years	0.06	0.08	-0.01	0.06	-0.04	-0.06	-	1.00																				
9 Male	0.19	0.16	0.30	-0.01	0.03	0.00	-0.04	-0.05	1.00																			
10 Age	-0.05	-0.02	0.03	-0.27	0.19	0.06	-0.14	-0.15	0.18	1.00																		
11 Household Net Income	0.29	0.14	0.28	0.11	-0.02	-0.10	0.04	0.02	0.14	-0.16	1.00																	
12 Household Wealth	0.11	0.10	0.17	-0.04	0.03	-0.02	-0.10	-0.01	0.06	0.08	0.08	1.00																
13 Socio Economic Status	0.31	0.20	0.31	0.11	-0.09	-0.13	0.01	-0.01	0.05	-0.13	0.33	0.12	1.00															
14 School Degree	-0.16	-0.15	-0.16	-0.14	0.09	0.06	0.03	-0.05	-0.01	0.29	-0.25	-0.07	-0.51	1.00														
15 Vocational Degree	0.01	0.02	-0.01	0.04	-0.04	0.03	-0.02	0.01	0.01	-0.17	0.05	-0.01	0.11	-0.71	1.00													
16 University Degree	0.19	0.17	0.22	0.11	-0.06	-0.11	0.00	0.04	-0.01	-0.14	0.25	0.10	0.55	-0.32	-0.42	1.00												
17 Married	0.15	0.07	0.12	-0.07	0.04	0.03	-0.05	-0.02	0.34	0.18	0.27	0.04	-0.01	0.01	0.04	-0.06	1.00											
18 Divorced	-0.02	-0.03	-0.05	0.02	-0.07	0.02	0.02	0.00	-0.18	0.05	-0.17	-0.03	-0.02	0.06	-0.06	-0.01	-0.33	1.00										
19 Number of Children in Household	0.07	0.05	0.00	0.20	-0.12	-0.04	0.05	0.04	0.01	-0.42	0.25	-0.07	0.08	-0.16	0.14	0.02	0.21	-0.02	1.00									
20 Self-employed	0.06	-0.02	0.03	0.04	-0.06	-0.01	-0.13	-0.08	-0.04	-0.09	0.11	-0.03	0.17	-0.04	0.01	0.04	-0.03	0.00	0.02	1.00								
21 Retired	0.03	0.01	0.06	-0.24	0.17	0.06	-0.08	-0.12	0.19	0.70	-0.08	0.09	-0.04	0.17	-0.10	-0.09	0.14	0.01	-0.36	-0.18	1.00							
22 Unemployed	-0.13	-0.05	-0.10	0.06	0.01	-0.05	-0.07	-0.04	-0.08	-0.07	-0.22	-0.04	-0.05	0.02	0.00	-0.02	-0.13	0.08	-0.05	-0.07	-0.21	1.00						
23 Government employee	0.07	0.09	0.07	0.05	-0.09	-0.05	0.02	0.05	-0.04	-0.20	0.14	0.00	0.07	-0.10	0.01	0.12	0.00	-0.01	0.11	-0.07	-0.19	-0.04	1.00					
24 Risk proneness	0.21	0.19	0.33	0.14	-0.01	-0.01	-0.07	0.01	0.19	-0.13	0.15	0.12	0.21	-0.15	0.01	0.19	-0.04	-0.04	0.07	0.02	-0.09	-0.03	0.04	1.00				
25 OLTV: Original Loan to Value Ratio	0.01	-0.04	0.00	0.06	-0.04	0.00	-0.01	0.03	-0.03	-0.18	0.16	-0.07	0.04	-0.10	0.07	0.01	0.01	-0.02	0.12	0.05	-0.21	-0.04	0.10	0.01	1.00			
26 CLTV: Current Loan to Value Ratio	0.04	0.05	0.07	0.29	-0.11	-0.13	0.07	0.14	-0.11	-0.58	0.32	-0.10	0.23	-0.27	0.06	0.22	-0.03	-0.07	0.30	0.01	-0.38	-0.01	0.16	0.09	0.26	1.00		
27 PTI: Payment to Income Ratio	-0.01	-0.04	-0.03	0.30	-0.23	-0.04	0.04	0.22	-0.03	-0.41	-0.07	-0.12	0.09	-0.13	0.06	0.07	-0.08	0.05	0.21	0.15	-0.31	0.06	0.11	-0.04	0.17	0.48	1.00	
28 Yfix: Year of Mortgage Origination	0.04	-0.05	0.04	0.04	0.00	-0.01	-	-0.45	-0.01	-0.08	0.05	-0.04	0.05	0.00	-0.03	0.03	0.06	-0.03	0.04	0.00	-0.03	0.05	-0.01	-0.05	-0.11	0.07	-0.07	1.00

Appendix 3 Financial Literacy

Table 3.12: Summary Statistics Basic Financial Literacy (N=872)

Panel A: Respondents who answered individual questions correctly / incorrectly / do not know

	Question				
	1	2	3	4	5
Correct	93%	85%	90%	68%	76%
N	809	745	786	590	662
Incorrect	5%	13%	5%	25%	21%
N	44	110	45	225	181
Don't know	2%	2%	5%	7%	3%
N	19	17	41	57	29

Panel B: Respondents with respective number of correct answers

	Number of corrects answers					
	None	1	2	3	4	5
Correct	0%	0%	3%	13%	35%	48%
N	0	4	28	113	308	419

Table 3.13: Summary Statistics Advanced Financial Literacy (N=872)

Panel A: Respondents who answered individual questions correctly / incorrectly / do not know

	Question										
	1	2	3	4	5	6	7	8	9	10	11
Correct	75%	74%	71%	69%	55%	83%	82%	34%	74%	60%	31%
N	651	644	619	600	476	723	716	296	649	527	266
Incorrect	8%	17%	13%	12%	28%	8%	11%	28%	9%	11%	41%
N	73	152	110	106	249	69	93	247	75	90	359
DK	17%	9%	16%	19%	17%	9%	7%	38%	17%	29%	28%
N	148	76	143	166	147	80	63	329	148	255	247

Panel B: Respondents with respective number of correct answers

	Number of correct answers											
	—	1	2	3	4	5	6	7	8	9	10	11
Correct	5%	2%	3%	4%	5%	7%	10%	14%	14%	15%	11%	11%
N	40	18	23	38	44	59	87	118	125	129	92	99

Appendix 4 Mortgage Risks

Table 3.14: Summary statistics perceived financial mortgage risk questions

R1: General Riskiness: Does having a mortgage pose a risk to your overall financial situation?		
Self-assessed	Frequency	Percent
Very high risk	18	2.98
High risk	103	11.81
Low Risk	427	48.97
No risk	298	34.17
I don't know	26	2.98
Total	872	100
R2: Income Risk: If you became unemployed for half a year, would that cause problems with servicing your mortgage?		
Self-assessed	Frequency	Percent
Yes	80	9.17
No	729	83.60
I don't know	63	7.22
Total	872	100
R3: Wealth Risk: If the market price of your house dropped 20%, would that cause you financial distress?		
Self-assessed	Frequency	Percent
Yes	59	6.77
No	745	85.44
I don't know	68	7.80
Total	872	100

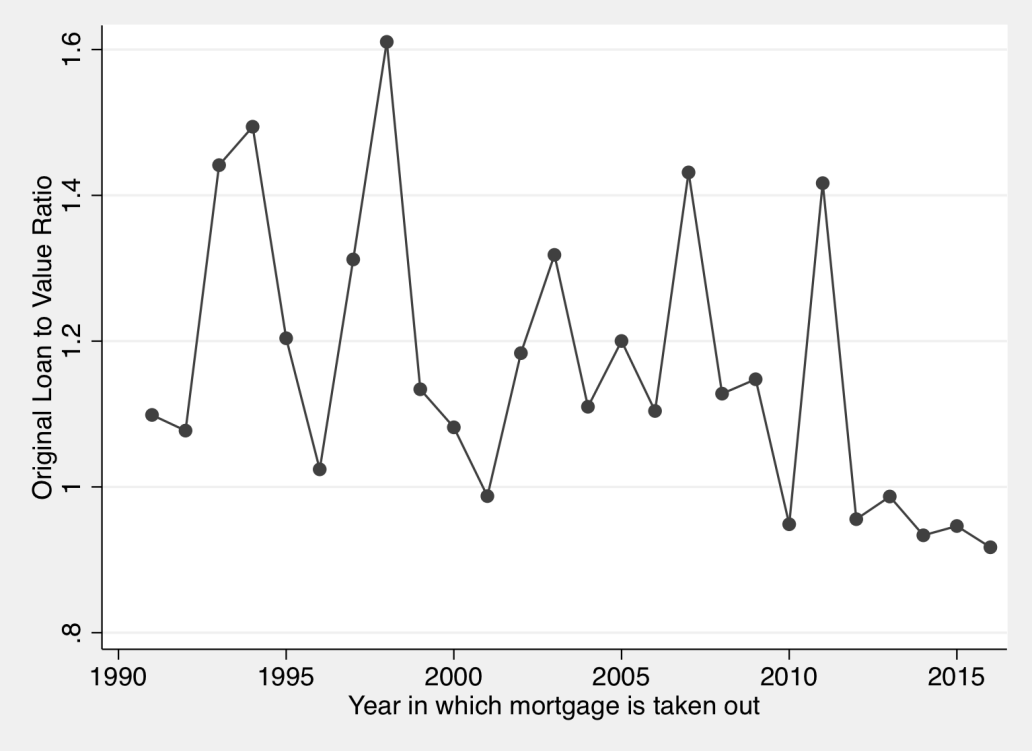

Figure 3.1: Plot of mean OLTV ratios in the Netherlands by year, 1990-2016

Appendix 5 Robustness Check Perceived Mortgage Risks

In the main text, we only analysed R1, the first question pertaining to general mortgage risk. Here we show that using R2 and R3 as dependent variables further supports the analysis in the main text. In Table 3.15, we use a probit analysis with the dummy reflecting whether respondents believe that they run into financial difficulties if they become unemployed (R2) as dependent variable in columns 1-3. In columns 4-6, the dependent variable is a dummy reflecting whether respondents believe that they will run into financial difficulties if the value of their house drops (R3). Column 1 and 4 shows results for mortgage literacy. Columns 2 and 5 show results for financial literacy. Columns 3 and 6 show results for mortgage and financial literacy together. All models include standard demographic controls as well as the objective risk measures OLTV, CLTV and PTI.

Mortgage literacy has the expected negative sign throughout, and is significant in column 3, at the 5% level. Basic financial literacy is significant only in column 2, at the 10% level. Advanced financial literacy is significant at 5% and 1% level respectively for income risk (Columns 2 and 3). However, the positive sign of the coefficient indicates that respondents who score higher in advanced financial literacy are more likely to report income vulnerabilities due to their mortgage. There are two possible and complimentary explanations for this result. First, advanced financial literacy may increase the sensitivity of borrowers to income risks associated with their mortgages. Second, respondents who score high in advanced financial literacy but low in mortgage literacy may assume that they understand mortgages better than they do. As a result, they may end up with riskier mortgages and do less to manage the income risks associated with their mortgages.

The robustness analysis supports the results from the regression in the main text. Mortgage literacy is negatively associated with perceived income and wealth vulnerability concerning mortgages even when financial literacy scores are included as dependent variables. Hence

mortgage literacy explains variation in income and wealth vulnerability due to mortgage risk over and above measured financial literacy.

Table 3.15: Regression results: Literacy scores and perceived income and wealth risks (R2 and R3)

Variables	(1) R2: Income Risk	(2) R2: Income Risk	(3) R2: Income Risk	(4) R3: Wealth Risk	(5) R3: Wealth Risk	(6) R3: Wealth Risk
Mortgage Literacy	-0.2422		-0.4478**	-0.2798		-0.3695
	(0.1575)		(0.1858)	(0.2057)		(0.2298)
Basic Financial Literacy		-0.2393*	-0.2247		0.0609	0.1148
		(0.1363)	(0.1374)		(0.1987)	(0.2045)
Advanced Financial Literacy		0.4695**	0.6649***		0.0238	0.1460
		(0.2023)	(0.2264)		(0.2020)	(0.2192)
Male	0.0363	-0.1750	-0.2359	0.2485	0.1920	0.1685
	(0.2741)	(0.2865)	(0.2974)	(0.3498)	(0.3606)	(0.3698)
Age (18-34 omitted)						
35-44 years	0.8603	0.7397	0.7185	0.8459	0.8658	0.9040
	(0.5999)	(0.5796)	(0.6291)	(0.5758)	(0.5737)	(0.5951)
45-54 years	0.7428	0.6201	0.6525	0.6580	0.6906	0.7079
	(0.6303)	(0.6071)	(0.6588)	(0.6242)	(0.6219)	(0.6435)
55-64 years	0.6094	0.4432	0.4543	-0.3416	-0.2792	-0.3034
	(0.6686)	(0.6567)	(0.7032)	(0.8204)	(0.8032)	(0.8318)
65 years and older	0.6308	0.5297	0.4499	-1.0485	-0.7298	-0.9374
	(0.8088)	(0.8052)	(0.8464)	(1.6568)	(1.7739)	(1.6450)
Education (School degree omitted)						
Vocational Education	0.2130	0.4028	0.1971	-0.2065	-0.0973	-0.2587
	(0.3657)	(0.3741)	(0.3850)	(0.5033)	(0.4918)	(0.5129)
University Education	0.5984	0.7307	0.5492	0.6334	0.6665	0.5678
	(0.4956)	(0.5090)	(0.5102)	(0.7110)	(0.7036)	(0.7169)
Log Household Income	-0.3769	-0.5376	-0.5264	0.0962	-0.0084	0.0483
	(0.3952)	(0.4205)	(0.4272)	(0.5562)	(0.5638)	(0.5710)
Log Household Wealth	-0.1291**	-0.1765***	-0.1508***	-0.1136*	-0.1306**	-0.1100*
	(0.0508)	(0.0508)	(0.0528)	(0.0581)	(0.0569)	(0.0591)
Socioeconomic Status	0.0123	-0.0638	-0.0254	-0.2192	-0.2318	-0.1974
	(0.1925)	(0.1978)	(0.1962)	(0.2591)	(0.2566)	(0.2608)
Married	-0.3239	-0.4116	-0.3491	-0.2839	-0.3009	-0.2118
	(0.3049)	(0.3247)	(0.3320)	(0.3821)	(0.3873)	(0.3889)
Divorced	0.1785	0.1515	0.2527	0.4675	0.4386	0.4796
	(0.5374)	(0.5247)	(0.5391)	(0.5881)	(0.5666)	(0.5967)
Number of Children in Household	0.1339	0.2024	0.1834	-0.1706	-0.1330	-0.1883
	(0.1314)	(0.1375)	(0.1399)	(0.1557)	(0.1506)	(0.1584)
Self-employed	0.1035	0.1952	0.2122	-0.2356	-0.2520	-0.1949
	(0.4941)	(0.5121)	(0.5277)	(0.6711)	(0.6744)	(0.6691)
Retired	-0.4914	-0.4389	-0.4635	0.7010	0.5217	0.6455
	(0.5917)	(0.6093)	(0.6207)	(1.5917)	(1.7143)	(1.5743)
Government worker	0.4084	0.6439*	0.5946*	-0.2910	-0.2400	-0.3460
	(0.3297)	(0.3384)	(0.3414)	(0.4332)	(0.4331)	(0.4481)
Risk proneness	0.0270	-0.0764	-0.0735	-0.1658	-0.2004	-0.2062
	(0.1565)	(0.1639)	(0.1686)	(0.1958)	(0.1971)	(0.2025)
Mortgage Characteristics						
OLTV	-1.1317**	-1.0562**	-1.0509**	-0.5632	-0.5627	-0.6105
	(0.4506)	(0.4555)	(0.4627)	(0.6557)	(0.6514)	(0.6827)
CLTV	0.6093	0.5697	0.6170	1.5817**	1.6280**	1.6829**
	(0.5631)	(0.5790)	(0.5888)	(0.6921)	(0.6927)	(0.7098)
PTI	1.3811	1.1259	1.2079	1.6282	1.0623	1.4815
	(1.2047)	(1.2255)	(1.2045)	(1.4252)	(1.3938)	(1.4579)
Unemployed	*omitted*	*omitted*	*omitted*	0.7103	0.7966	0.6714
				(0.6235)	(0.6071)	(0.6290)
Constant	2.4013	4.2513	4.0136	-1.6858	-0.7762	-1.4355
	(3.0036)	(3.2139)	(3.2637)	(4.2493)	(4.3128)	(4.3725)
Observations	368	368	368	383	383	383
Pseudo R-squared	0.270	0.296	0.325	0.364	0.353	0.370

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 3.16: Regression results: Literacy scores and perceived mortgage risk (R1) (only Qs 1-4 for Mortgage Risk Questionnaire)

Variables	(1)	(2)	(3)	(4)
Mortgage Literacy (Qs 1-4)	-0.0251	-0.1395**		-0.1616**
	(0.0411)	(0.0600)		(0.0653)
Basic Financial Literacy			-0.0038	0.0080
			(0.0521)	(0.0520)
Advanced Financial Literacy			-0.0055	0.0531
			(0.0607)	(0.0648)
Male	0.0347	0.0037	-0.0015	-0.0190
	(0.0788)	(0.1061)	(0.1100)	(0.1095)
Age (18-34 omitted)				
35-44 years	-0.0634	-0.3197	-0.2907	-0.3258
	(0.1524)	(0.2137)	(0.2159)	(0.2148)
45-54 years	-0.3271**	-0.6328***	-0.6016***	-0.6380***
	(0.1495)	(0.2154)	(0.2176)	(0.2166)
55-64 years	-0.4412***	-0.4858**	-0.4648**	-0.4936**
	(0.1499)	(0.2229)	(0.2257)	(0.2244)
65 years and older	-0.4509**	-0.5719**	-0.5393**	-0.5815**
	(0.1815)	(0.2699)	(0.2730)	(0.2716)
Education (School degree omitted)				
Vocational Education	0.0375	0.1060	0.1466	0.1078
	(0.0842)	(0.1137)	(0.1138)	(0.1140)
University Education	0.1565	0.2323	0.2686	0.2278
	(0.1333)	(0.1648)	(0.1656)	(0.1652)
Log Household Income	-0.0416	0.1843	0.1824	0.1705
	(0.0918)	(0.1445)	(0.1466)	(0.1456)
Log Household Wealth	-0.0270**	-0.0337	-0.0424**	-0.0356*
	(0.0136)	(0.0205)	(0.0206)	(0.0207)
Socioeconomic Status	0.0392	0.0190	-0.0007	0.0136
	(0.0463)	(0.0610)	(0.0615)	(0.0614)
Married	-0.0457	0.0702	0.0636	0.0732
	(0.0848)	(0.1108)	(0.1118)	(0.1111)
Divorced	0.0608	-0.0976	-0.1089	-0.0981
	(0.1529)	(0.1988)	(0.2005)	(0.1991)
Number of Children in Household	0.0750*	0.0908*	0.0939*	0.0939*
	(0.0426)	(0.0526)	(0.0532)	(0.0528)
Self-employed	0.0603	0.1823	0.1615	0.2010
	(0.1544)	(0.2061)	(0.2085)	(0.2076)
Retired	-0.2110	-0.1031	-0.0877	-0.0996
	(0.1333)	(0.1856)	(0.1874)	(0.1861)
Unemployed	0.1950	0.0748	0.1121	0.0651
	(0.1736)	(0.2278)	(0.2294)	(0.2285)
Government worker	-0.0956	0.0841	0.0971	0.0837
	(0.1145)	(0.1368)	(0.1387)	(0.1378)
Risk proneness	0.1363***	0.1245**	0.1172**	0.1118**
	(0.0420)	(0.0539)	(0.0563)	(0.0560)
Mortgage Characteristics				
OLTV		-0.1054	-0.1163	-0.1053
		(0.1142)	(0.1151)	(0.1144)
CLTV		-0.0004	0.0009	0.0055
		(0.1929)	(0.1949)	(0.1935)
PTI		1.5600***	1.5425***	1.5300***
		(0.4647)	(0.4702)	(0.4669)
Constant	0.7912	-1.0350	-0.9684	-0.8741
	(0.7083)	(1.1007)	(1.1259)	(1.1186)
Observations	814	383	383	383
R-squared	0.1231	0.2465	0.2352	0.2480
Adjusted R-squared	0.102	0.200	0.186	0.198

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix 6 Robustness Check Mortgage Risk Management

The regression below repeats the regression in section 3.6.2 with a revised mortgage literacy measure excluding question 1 on the advantages of rate fixing from the calculation of the score.

Table 3.17: Regression results: Literacy scores and interest-rate fixing, with revised mortgage literacy score

Variables	(1)	(2)	(3)
Mortgage Literacy without Q1	0.2207**		0.1893**
	(0.0883)		(0.0950)
Basic Financial Literacy		0.0592	0.0394
		(0.0900)	(0.0915)
Advanced Financial Literacy		0.1467	0.0767
		(0.1011)	(0.1083)
Male	-0.0019	-0.0380	-0.0449
	(0.1840)	(0.1879)	(0.1904)
Age (18-34 omitted)			
35-44 years	-0.1066	-0.0706	-0.0915
	(0.4147)	(0.4040)	(0.4131)
45-54 years	-0.1616	-0.1260	-0.1410
	(0.4050)	(0.3972)	(0.4051)
55-64 years	-0.6416	-0.5659	-0.6291
	(0.3946)	(0.3840)	(0.3949)
65 years and older	-0.8373*	-0.7907*	-0.8242*
	(0.4632)	(0.4567)	(0.4646)
Education (School degree omitted)			
Vocational Education	-0.3495*	-0.3915*	-0.3471*
	(0.2053)	(0.2040)	(0.2057)
University Education	-0.5422*	-0.5981**	-0.5430*
	(0.3035)	(0.3007)	(0.3037)
Log Household Income	0.3571*	0.3294	0.3376
	(0.2115)	(0.2125)	(0.2134)
Log Household Wealth	0.0252	0.0260	0.0214
	(0.0300)	(0.0302)	(0.0304)
Socioeconomic Status	0.0733	0.0962	0.0637
	(0.1076)	(0.1070)	(0.1084)
Married	-0.2919	-0.2673	-0.2898
	(0.1941)	(0.1934)	(0.1946)
Divorced	0.0931	0.1502	0.0957
	(0.3877)	(0.3795)	(0.3875)
Number of Children in Household	-0.0435	-0.0475	-0.0436
	(0.1010)	(0.1009)	(0.1012)
Self-employed	-0.9937***	-0.9510***	-0.9770***
	(0.2960)	(0.2978)	(0.2975)
Retired	-0.0608	-0.0756	-0.0589
	(0.3146)	(0.3157)	(0.3163)
Unemployed	-0.6653*	-0.7204**	-0.6897*
	(0.3594)	(0.3570)	(0.3611)
Government worker	-0.2034	-0.2138	-0.2132
	(0.2483)	(0.2487)	(0.2497)
Risk proneness	-0.2612***	-0.2847***	-0.2860***
	(0.0967)	(0.1001)	(0.1009)
Constant	-1.0270	-0.8896	-0.8006
	(1.6213)	(1.6425)	(1.6534)
Observations	533	533	533
Pseudo R-squared	0.112	0.105	0.114

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix 7 Instrumental Variable Approach

Table 3.18: Second stage regression with perceived mortgage risk (R1) as dependent variable

Variables	(1)
Mortgage Literacy	-2.3332**
	(1.1464)
Basic Financial Literacy	0.0538
	(0.2048)
Advanced Financial Literacy	0.7962*
	(0.4836)
Male	-0.3776
	(0.3831)
Age (18-44 omitted)	
45-54 years	0.0738
	(0.5435)
55-64 years	0.5027
	(0.6524)
65 years and older	-0.3993
	(0.6622)
Education (School degree omitted)	
Vocational Education	-0.8246*
	(0.4666)
University Education	-0.9904
	(0.6311)
Log Household Income	0.5094
	(0.4903)
Log Household Wealth	-0.0377
	(0.1113)
Socioeconomic Status	0.0907
	(0.2138)
Married	-0.2069
	(0.3847)
Divorced	-0.0022
	(0.5973)
Number of Children in Household	0.1711
	(0.1566)
Self-employed	0.1885
	(0.4937)
Retired	0.0343
	(0.3646)
Unemployed	-1.2553
	(1.1171)
Government worker	-0.3444
	(0.4453)
Risk proneness	0.1216
	(0.2043)
Mortgage Characteristics	-0.2320
OLTV	(0.3516)
	-0.5980
CLTV	(0.6951)
	4.4054**
PTI	(2.0530)
	-2.5483
Constant	(3.3997)
Observations	131
p-value endogeneity test	0.0024
p-value Hansen OIR test	0.2447

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3.19: First stage regression

Variables	(1)
Basic Financial Literacy	0.0534
	(0.0870)
Advanced financial Literacy	0.3006**
	(0.1221)
Male	-0.0710
	(0.1814)
Age (18-44 omitted)	
45-54 years	0.2107
	(0.2710)
55-64 years	0.3207
	(0.2979)
65 years and older	-0.0006
	(0.3353)
Education (School degree omitted)	
Vocational Education	-0.2687*
	(0.1540)
University Education	-0.3348
	(0.2147)
Log Household Income	0.0157
	(0.2325)
Log Household Wealth	-0.0339
	(0.0512)
Socioeconomic Status	0.0085
	(0.0911)
Married	-0.0997
	(0.1484)
Divorced	0.1315
	(0.2535)
Number of Children in Household	-0.0054
	(0.0835)
Self-employed	0.1401
	(0.2132)
Retired	0.0149
	(0.1647)
Unemployed	-0.5633
	(0.4014)
Government worker	-0.0186
	(0.2168)
Risk proneness	-0.0097
	(0.0860)
Mortgage Characteristics	
OLTV	-0.0087
	(0.1593)
CLTV	-0.2219
	(0.3234)
PTI	0.9797
	(0.7542)
Basic Financial Literacy 2006	-1.4329
	(1.4565)
Advanced financial literacy 2006	0.2983*
	(0.1642)
Constant	0.8325
	(1.6151)
Observations	131
F(2, 106)	1.9
R-squared	0.30

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4 Developing and Validating the Intellectual Virtue Scale

4.1 Introduction

This chapter develops and validates the Intellectual Virtue Scale (IVS). Intellectual virtues are acquired character traits that support gaining knowledge and understanding (Zagzebski 1996; Montmarquet 1993; Roberts and Wood 2007). Research on intellectual virtues has so far mainly been conducted in philosophy, which has led to an emphasis on conceptual and theoretical matters (Battaly 2008). Only recently have researchers started to interrogate the empirical underpinnings of intellectual virtue (Fairweather and Flanagan 2014). There has also been some interest by psychologists, experimental philosophers, and researchers on education in notions closely related to intellectual virtue (Peterson and Seligman 2004; Tetlock et al. 2000; Lerner and Tetlock 1999; Tetlock 1983, 2005; Alfano et al. 2017).

The IVS is to our knowledge the first scale that measures a broad spectrum of intellectual virtues. We measure the virtues of love of knowledge, open-mindedness, conscientiousness, humility, and courage with four items for each virtue. The resulting 20-item scale is the first instrument to measure intellectual virtues comprehensively.

The scale can be employed to investigate causes and effects of intellectual virtue. Prior research suggests that intellectual virtue is related to knowledge, justification of beliefs, and understanding (Zagzebski 1996). The IVS allows us to test the effects of intellectual virtue empirically. Do intellectually virtuous people have more true beliefs and fewer false ones? Are their beliefs better justified? Do they understand issues better? Are they more keenly aware of the limitations of their knowledge? The IVS can also be used as an outcome measure. To what extent do education and training interventions support intellectual virtue?

Being deficient in intellectual virtue is to be intellectually vicious. Examples of deficits in intellectual virtue are epistemic injustice (Fricker 2007), shallowness (De Bruin 2014), and gullibility (Cassam 2016). Prior research suggests that epistemic vice explains why some people end up with unsupported or wrong beliefs. For instance, gullibility may explain why people believe in conspiracy theories (Cassam 2016). The Intellectual Virtue Scale can be used to investigate the relationship between intellectually vicious behaviour and intellectual vice as a character trait. Moreover, the scale can be used to investigate whether intellectual virtue affects learning, personal finance, political views, life satisfaction, and many other areas.

But epistemic vice can also come in the form of an excessive concern with knowledge and understanding. For instance, an excess of intellectual conscientiousness and humility can lead to scruples and paralysis. We define a virtue as a mean between a deficit and an excess. The IVS mirrors this structure by asking respondents to place themselves on a five-point scale with the deficit and the excess descriptions attached to the leftmost and rightmost scale point respectively, and the mean description in the middle.

Section 4.2 introduces the concept of intellectual virtue. Section 4.3 discusses our approach to measuring intellectual virtue. In section 4.4, we define the intellectual virtues we measure. Section 4.5 reports the results of the validation studies. Section 4.6 discusses strengths and limitations of the Intellectual Virtue Scale and provides an outlook for further research.

4.2 The Concept of Intellectual Virtues

We define intellectual virtues as acquired character traits that support gaining knowledge and understanding (Zagzebski 1996; Montmarquet 1993; Roberts and Wood 2007). Intellectual virtues dispose their bearers to seek knowledge, gather and process information in an open-minded and conscientious way, and adjust their beliefs diligently.

Note that our definition excludes other-regarding and deliberative intellectual virtues. An example of an other-regarding epistemic virtue is intellectual generosity—the disposition to share knowledge freely. An example of a deliberative virtue is the disposition to express yourself clearly. We exclude other-regarding and deliberative intellectual virtues because they do not, in the first instance, increase the tendency of their bearers to acquire knowledge. Both are important however, calling for future work.

4.2.1 Intellectual virtues in contrast to related constructs

Intellectual virtues differ from personality traits as measured by the Big Five (Donnellan et al. 2006) in that intellectual virtues are traits that support gaining knowledge and understanding. These traits include dispositions to search for information, form and revise beliefs, and communicate and discuss beliefs. While measures of personality traits capture some aspects of intellectual virtue at least in a general way (e.g. openness to experience, conscientiousness), the Intellectual Virtue Scale allows for a more specific and more differentiated assessment of intellectual virtue. In section 4.5.7, we demonstrate that the intellectual virtues we test are distinct from related personality traits.

Intellectual virtues also differ from moral virtues or character strengths, such as benevolence or justice. The *Virtues in Action Scale* (VIA) measures a range of moral virtues (Peterson and Seligman 2004). The difference between moral virtues and intellectual virtues is that the former are traits regulating *moral* conduct, while the latter regulate *epistemic* conduct – the way people deal with information. For example, the VIA measures justice, including teamwork, fairness, and leadership. By contrast, the IVS focuses on virtues that are directly relevant for dealing with information, such as gathering, processing, and evaluating information.

We grant that some forms of behaviour are open to moral as well as intellectual evaluation. For example, epistemic injustice occurs when we pay insufficient attention to certain speakers, for

instance because of their gender, ethnic background, or political adherence (Fricker 2007). Epistemic injustice is an intellectual failing, because it draws us away from the truth. But epistemic injustice is a moral failing as well. Behaving morally involves treating others with respect. Discounting someone's views on the ground of their gender or skin colour fails to take them seriously as thinkers. The notion of intellectual injustice shows that an action can be subject to both moral and epistemic evaluation. But despite their intimate relation, epistemic and moral virtues are conceptually distinct. Moral virtues facilitate morally excellent action. By contrast, epistemic conduct supports knowledge and understanding. Section 4.5.7 demonstrates that moral virtues as measured by the VIA and intellectual virtues are not only conceptually, but also psychologically distinct.

Intellectual virtues differ from intelligence in that intellectual virtues are acquired character traits. We think about intelligence as raw cognitive ability (Bartholomew 2004), whereas intellectual virtues determine how this raw capacity is brought to bear on epistemic activities. Two equally intelligent persons may differ in intellectual courage. For instance, one of them may be too cowardly to challenge a superior. If so, intellectual virtues should explain variance in knowledge and understanding that intelligence alone cannot account for.

Finally, intellectual virtues are also different from cognitive skills such as memory, speech, writing, and reading (Royer, Cisero, and Carlo 1993). Cognitive skills are about whether we have mastered certain cognitive abilities. By contrast, intellectual virtues are about *how* we engage in these cognitive activities. For example, two people might have mastered reading to the same level of skill, but differ in intellectual humility. Confronted with the same newspaper article about the consequences of Brexit, the humble reader uses her reading skills to test and refine her beliefs on the matter, increasing her knowledge and understanding. By contrast, arrogant readers do not take the views expressed in the reading seriously, and thereby fail to challenge their beliefs.

4.2.2 Features of our conception of Intellectual Virtue

Our conception of intellectual virtue is grounded in new work in virtue epistemology (Zagzebski 1996; Montmarquet 1993; Roberts and Wood 2007; Morton 2012; Fricker 2007; De Bruin 2013; Baehr 2011, 2006; Fairweather and Zagzebski 2001). Research in virtue epistemology makes people rather than beliefs the primary focus of study (Battaly 2008). Agents are evaluated in terms of the intellectual virtues and vices they display in dealing with information. According to virtue epistemology, whether a belief is justified or even amounts to knowledge depends on whether it is the product of virtuous epistemic conduct.

The task of designing a measurement instrument based on virtue epistemology is complicated by the fact that there is a family of different views that differ on deep theoretical issues (Battaly 2006). Where possible, the IVS takes a neutral stance towards these differences. We emphasize what virtue theorists have in common: a focus on the exploration of intellectual virtues. A justified belief is seen as "what a person who is motivated by intellectual virtue, and who has the understanding of his cognitive situation a virtuous person would have, might believe in like circumstances" (Zagzebski 1996, 241).

There is, however, one distinction within virtue epistemology where we take sides. So-called reliabilists maintain that intellectual virtues are faculties, such as perception, induction, and memory (Sosa 2000). By contrast, we follow here the so-called responsibilist approach, according to which intellectual virtues are states of character rather than natural faculties (Zagzebski 1996; Montmarquet 1993; Roberts and Wood 2007; Baehr 2011). The important difference to reliabilism is that responsibilists are interested in features of character that can in principle be acquired and nurtured. It is of course an empirical question to what extent intellectual virtues are in fact malleable through interventions or self-cultivation. From the perspective of scale construction, the important point is to focus on things that in principle

could be influenced by training, such as habits, attitudes and traits, rather than the existence of the faculties themselves (Battaly 2006; Fairweather and Flanagan 2014).

4.3 Measuring Intellectual Virtues

In this section, we introduce our approach to measuring intellectual virtue. In section 4.3.1, we discuss the scaling method we use to capture the structure of intellectual virtue as a mean between two extremes. In section 4.3.2, we discuss the dimensionality of the scale. In section 4.3.3, we consider challenges posed by self-assessment.

4.3.1 Scaling

As mentioned in section 4.2.1, we conceive of virtues as a mean between two vicious extremes. For example, courage is a mean between cowardice and recklessness. The same structure applies to intellectual virtues. Table 4.1 maps the virtues we measure to their respective deficits and excesses.

Table 4.1: Mapping of intellectual virtues to their deficits and excesses

Deficit	Virtue	Excess
Indifference towards knowledge	Love of knowledge	Idolatry of knowledge
Narrow-mindedness in gathering information	Openness in gathering information	Heedlessness in gathering information
Carelessness in evaluating information	Conscientiousness in evaluating information	Scrupulousness in evaluating information
Pretension in belief formation	Humility in belief formation	Self-depreciation in belief formation
Intellectual cowardice	Intellectual courage	Intellectual recklessness

We discuss the definitions of the virtues in section 4.4. The point for now is that the structure of virtues poses a challenge for developing and scaling items. A common approach is to use a Likert-type scale (DeVellis 2016). Likert-type scales ask respondents to what degree they

endorse or agree with a given statement. This approach works best for traits that are more or less present in any given respondent. The information that can be extracted from an answer to a Likert-type item is *to what extent* a trait is present in respondents. An example of an item measuring humility is "I proportion the strength of my beliefs to the strength of my evidence." Answer options may range from strongly agree to strongly disagree.

The statement reflects a virtuous way of forming beliefs, avoiding the pitfalls of pretension ("I know everything") and self-depreciation ("I don't know anything"). A limitation of scaling items this way is that it does not allow to differentiate between self-depreciatory and pretentious respondents. Both of these groups should disagree with the statement. But they disagree for opposite reasons. The pretentious person disagrees because they lack humility, whereas the self-deprecatory person disagrees because they have humility in excess.

There are several ways in which this drawback can be avoided. One is to develop three scales, measuring virtue, deficit, and excess each individually. An advantage of this approach is that finding inverse correlations between the scales provides an additional internal validation point. A major drawback is however that the number of items is tripled.

Our alternative approach is to assign three statements to each item: a deficit description, a virtue description, and an excess description. Items are scored on a five-point scale. The deficit description is attached to the leftmost scale point, the virtue description to the middle scale point, and the excess description to the rightmost scale point. The remaining two scale-points do not have a statement attached. They mark intermediate positions between deficit and virtue, and virtue and excess, respectively. An example of an item measuring humility has "I hold my beliefs firmly even in areas I know little about" as the leftmost deficit option; "I proportion the strength of my beliefs to the strength of my evidence" as the middle option; and "I hardly have any strong beliefs even in areas I know a lot about" as the excessive right-most option.

The advantage of this approach is that we can distinguish the direction in which people diverge from the virtue with a single item. This method allows us not only to determine to what extent respondents are intellectually virtuous, but also whether they tend more towards excess or towards deficit concerning specific virtues.

4.3.2 Dimensionality

Is intellectual virtue an integrated construct, or should we differentiate different intellectual virtues? This apparently theoretical question has important repercussions for scale development. The former option would call for a single integrated scale. The latter option, by contrast, calls for differentiating different subscales for each intellectual virtue.

The so-called doctrine of the "unity of the virtues" appears to align with the first option to construct one integrated scale. The unity of the virtues is the doctrine that the virtues are interdependent, such that a person cannot have any of the virtues without having all others (Wolf 2007). The doctrine goes back to Aristotle (Aristotle 2009, 1145a1-2). In other words, the intellectual virtues may be conceptually distinct without being psychologically distinct. While we can conceptually distinguish between different intellectual virtues, factor analysis will not be able to pick up these differences (Clayton Peterson 2017). The reason is that according to the doctrine of the unity of the virtues, possession of the virtues co-varies despite the conceptual distinctions between them.

The unity of the virtues raises a possible concern with using factor analysis in scale development. Factor analysis is a statistical method that extracts common factors explaining covariation between items. It is common practice in psychology to test whether items really tap into a well-defined construct to subject items to a factor analysis (DeVellis 2016; DeBode et al. 2013). Items that tap into the same construct should strongly load on the same factor without large cross loadings on different factors. The objection is that if virtues strongly co-

vary, factor analysis may lead us to discard items that tap into one specific virtue. Since possession of virtues co-varies, items pertaining to one virtue would show large cross-loadings on other virtues. Large cross-loadings count against the inclusion of these items in the final scale according to standard methodology, because they are perceived to indicate that the item does not measure just one but several constructs. But according to the doctrine of the unity of the virtues, it would appear that we should expect to find cross-loadings even with items that tap into one specific virtue exclusively generally.

If the doctrine of the unity of the virtues is correct in the sense that virtues strongly co-vary, we expect that all items display significant cross-loadings. But the exploratory factor analysis reveals that many items do not display any large cross-loadings (section 4.5.4). Therefore, we distinguish subscales for each of the virtues we seek to measure.

4.3.3 Challenges of Self-Assessment

We administer the IVS as a self-assessment questionnaire. Self-assessment has two advantages. First, data gathering is relatively unproblematic. Through online services like Amazon Mechanical Turk researchers have easy access to a large pool of participants (Buhrmester, Kwang, and Gosling 2011; Paolacci and Chandler 2014). Second, participants retain a high degree of autonomy over how they are described and rated. But this latter feature also gives rise to two potential drawbacks of self-assessment. First, respondents may lack the self-knowledge necessary to respond to items adequately (Dunning, Heath, and Suls 2004). Second, respondents may fail to answer according to their self-assessment (McGrath et al. 2010).

Consider whether respondents have the appropriate self-knowledge to respond to the items in the Intellectual Virtue Scale appropriately (Vazire 2010). We do not see major challenges concerning the virtues love of knowledge, open-mindedness, conscientiousness, and intellectual courage. We have all experienced countless situations that allowed us to compare

our curiosity to the curiosity of others, how conscientiously we and others process information, and how courageously we have pursued the truth in challenging circumstances as compared with others.

Self-knowledge about intellectual humility however may be more tenuous. One feature of the truly humble may be that they do not think about themselves as particularly humble. The boastful, on the other hand, are unlikely to fully appreciate their lack of intellectual humility. In effect, the pretentious as well as the self-depreciatory may well lack the self-knowledge necessary to answer questions on intellectual humility correctly.

Consider now whether participants will respond to the items in the Intellectual Virtue Scale truthfully. We have deliberately refrained from tricking participants into revealing their intellectual virtues or lack thereof unwittingly. Recall that the Intellectual Virtue Scale has a very transparent structure, with the statement reflecting a virtuous character trait always in the middle of the scale. Participants who want to appear intellectually virtuous can therefore very easily do so. The transparency of the scale limits its application to cases where respondents do not have strong incentives to answer in socially desirable ways. But in the absence of strong incentives to appear virtuous, the motive of self-discovery gives respondents a reason to answer truthfully.

Note that the problems with self-assessment just outlined do not affect the development of the Intellectual Virtue Scale. The development of the scale would be affected if, for instance, challenges with self-assessment would lead to the selection of different items. The problem is rather with the adequacy of the assessment. Insofar as respondents are mistaken with regard to the items considered, the Intellectual Virtue Scale will suggest a higher or lower level of virtue than respondents actually have. In order to mitigate this problem, we suggest to respondents to compare themselves with people around them they know well. Moreover, we selected items that require only a modest amount of self-knowledge, for instance by asking about concrete

behaviours. Nonetheless, these challenges of self-assessment constitute a limitation of the Intellectual Virtue Scale. As in the case of other psychometric scales relying on self-assessment, these doubts can be mitigated, but not entirely put to rest looking at internal reliability alone. Studies of construct validity are best suited to evaluate how serious the problems of self-assessment truly are (cf. chapter 5). If the IVS relates to outcomes as predicted, this provides strong evidence that the challenges of self-assessment are limited in practice. After all, other measures like the Big Five personality measures enjoy good construct validity, while facing similar challenges to the IVS (Barrick and Mount 1991; Robins, Fraley, and Krueger 2009, chap. 13).

4.4 Definition of Constructs and Hypotheses

In this section, we provide definitions of our constructs. We also show how our definitions of intellectual virtues relate to other classifications developed by philosophers.

Our starting point for differentiating intellectual virtues is three different phases of information processing. First, the selection of evidence, sources, and interlocutors; second, the evaluation of evidence; and third the formation of beliefs of varying strengths. We postulate three intellectual virtues mapping on the three phases of epistemic conduct: open-mindedness on belief gathering, conscientiousness on the evaluation of evidence, and humility on forming beliefs. Moreover, we postulate two further epistemic virtues pertaining to all three phases jointly. Love of knowledge propels people to exercise the other intellectual virtues. Intellectual courage supports people in overcoming fears that threaten to undermine the exercise of intellectual virtues. We define the five intellectual virtues as follows:

Love of Knowledge or curiosity is the disposition to actively and purposefully seek knowledge and understanding. Love of knowledge supports and enables the exercise of the other intellectual virtues by motivating their bearers to pursue knowledge and understanding.

Open-mindedness in gathering information is the disposition to take up different standpoints and perspectives in seeking out evidence and being impartial in appraising the reliability of sources of information. Open-mindedness relates to the information-gathering phase of processing information, concerning the selection of evidence, sources, and interlocutors.

Conscientiousness in evaluating information is the disposition to evaluate evidence methodically, thoroughly, and carefully. Conscientiousness relates to the evaluation of information, pertaining to acknowledging, comparing, and weighing information according to its relevance and merits.

Humility in belief formation is the disposition to acknowledge you may be wrong, and to proportion the strength of your beliefs to the strength of your evidence. Humility pertains to the formation and revision of beliefs, including striking the right balance between over- and under-confidence.

Intellectual Courage is the disposition to pursue knowledge and understanding even if this may negatively affect your wellbeing. Similar to love of knowledge, intellectual courage supports and enables the exercise of other intellectual virtues by fostering resilience in dealing with risks and fears in acquiring knowledge and understanding.

To validate our taxonomy of intellectual virtues, we compare it with other leading classifications. Our classification can be seen as a consensus definition that integrates the major concerns of the leading proposals in virtue epistemology. Appendix 8 shows the mapping of three major taxonomies of intellectual virtue on our taxonomy (Roberts and Wood 2007; Montmarquet 1993; Zagzebski 1996). Except for the other-regarding and deliberative virtues which we exclude from our analysis, the Intellectual Virtue Scale can accommodate each of the virtues proposed in these alternative classification systems.

It should be noted that we do not claim to have covered all character traits that regulate epistemic activity, for two reasons. First, some leading virtue epistemologists shun the idea of a comprehensive classification of intellectual virtues in the first place (Zagzebski 1996; Fricker 2007). Instead, they investigate specific epistemic virtues, leaving open whether there might be others. Second, the language of virtues is flexible and open-ended, which makes it impossible even in principle to ensure completeness. Nevertheless, we are confident that we cover a broad range of intellectual virtues.

4.5 Validation

4.5.1 Overview of Validation Steps

We follow the validation procedure suggested by DeVellis (DeVellis 2016).

Drafting. We draft more than 300 items, none of which makes it into the final version of the scale in their original form. We develop items based on the definitions given above, as well as examples presented in the literature on intellectual virtue. We also review existing related scales and take inspiration for our items.

Expert Validation. We elicit detailed feedback on the item pool from a number of experts in philosophy working on intellectual virtues, which leads to a fundamental revision of the item pool.

Discrimination analysis. We ask a convenience sample of 20 participants to rate items depending on how well they reflect each of the intellectual virtues. This step helps us in identifying items that tap into exactly one of the virtues that we seek to measure and leads to a further revision of the item pool.

Exploratory factor analysis. We ask 1,000 participants recruited on Amazon Mechanical Turk to respond to all items in the revised item pool. The analysis reveals that a subset of the items

has a clean factor structure, with items belonging to the same intellectual virtue loading on the same factor. We optimise scale length based on substantive and internal validity considerations. We select 20 items, with 4 items per virtue, as candidate items for the final scale.

Confirmatory factor analysis. We ask another 1,000 participants on Amazon Mechanical Turk to respond to the 20 items identified during the exploratory factor analysis. We find that the factor structure remains stable in the confirmatory analysis. The final Intellectual Virtue Scale consists of the 20 items identified in the exploratory factor analysis.

Convergence and Divergence analysis. While gathering data for the confirmatory data analysis, we also ask participants to fill in a number related scales to determine convergent and divergent validity. We find that the Intellectual Virtue Scale taps into a construct that is distinct from related personality traits and moral virtues.

4.5.2 Study 1: Expert Validation

The purpose of the expert validation is to ensure that we are capturing the whole domain of intellectual virtue and that our items capture each intellectual virtue appropriately. We present a selection of 80 items from the initial item pool to philosophers working on intellectual virtues and at the intersection of philosophy and psychology. Participating experts are Jason Baehr (Loyola Marymount University), Linda Zagzebski (University of Oklahoma), Olivia Bailey (Harvard University), Megan Haggard (University of Oklahoma), Kate Vredenburgh (Harvard University), and Miranda Fricker (City University of New York).

The expert review takes the form of an online survey, and is structured as follows. First, we present experts with a project outline and definitions of all virtues. Second, we ask experts to rate items according to how well they reflect the virtue they are meant to capture, on a three-point scale from “very well” to “not well at all”. Third, we ask for free-text suggestions for

revising each of the items. Finally, we ask experts at the end of each section dedicated to a virtue whether they have suggestions for additional items.

The expert feedback leads us to revise more than 80% of the items, add new items, and discard others. The result is a list of 55 revised items, with at least ten items for each virtue.

4.5.3 Study 2: Discrimination Analysis

The purpose of the discrimination analysis is first to ensure items are comprehensible. Second, the aim is to identify items that pertain to one and only one virtue. The reason this is important is that items which pertain to several virtues will load on several factors in the factor analysis. This is typically regarded as a reason to discard such items (DeVellis 2016; Hinkin 1995). Moreover, to test the hypothesis that virtues co-vary discussed in section 4.3.2, we need items that pertain only to single virtues.

We ask a convenience sample of 20 people to participate in the discrimination analysis in the form of an online questionnaire. After providing participants with some background on the Intellectual Virtue Scale, we first ask participants for each of the items how they rate its comprehensibility on a three-point scale from "understanding this item is easy" to "the meaning of this item is not clear to me". Second, we ask to what degree each item reflects each of the five intellectual virtues, again on a three-point scale from "the item does not reflect the virtue at all" to "the item strongly reflects the virtue." Participants have no information about which virtue each item was intended to reflect. Additionally, participants can leave comments suggesting improvements of each of the items.

If participants on average judge an item to reflect another virtue than the one we had intended most, we discarded or revised the item. Next, we compute the *mean endorsement* value of each item for the dominant virtue. The mean endorsement value has its lower bound at 0, indicating that the item does not reflect the virtue at all, and its upper bound at 2, indicating that the item

strongly reflects the item. We discard items with a lower dominant item endorsement than 1.5. Next, we consider the *balanced endorsement score* for each item. We compute this score by subtracting the sum of the mean endorsement values for all but the dominant virtue from the mean endorsement value for the dominant virtue. The balanced endorsement score measure is bounded between -8 and 2. We discard all items with a negative balanced endorsement score. In effect, the strength of reflection of the dominant virtue needs to exceed the strength of reflection of all of the other virtues. Finally, we compute the *comprehensibility score* by subtracting the share of respondents who rated the item as having medium clarity or being unclear from the share of people who rated it as easy to understand. This measure is bounded between -2 and 1. We discarded or revised items with comprehensibility below 0.8, ensuring high comprehensibility ratings.

Of the 55 items reviewed, 26 items survive these tests unchanged, 14 items miss some test narrowly, and 15 items fail at least one test clearly. We discard the clearly failed items, revise the items that miss some test narrowly, and keep the items that pass the tests, sometimes with slight revisions. Revisions are motivated by two pilot studies with 100 respondents each recruited on Amazon Mechanical Turk. 0 shows the measures discussed for each item in the discrimination analysis.

4.5.4 Study 3: Exploratory Factor Analysis

The purpose of the exploratory factor analysis is, first, to determine the dimensionality of the scale using factor analysis. Dimensionality determines the number of subscales, if any. The second purpose of the exploratory factor analysis is to optimise scale length and select the best items for the final scale.

We recruit 1,801 respondents on Amazon Mechanical Turk and administer the 40 revised items, with eight items per intellectual virtue. We present items in random order. To ensure

participants answer diligently, we include two attention checks. 236 participants miss the first attention check, 568 miss the second check. We exclude participants who fail either check from the analysis. To further improve data quality, we drop all respondents who take less than three minutes to complete the survey (median: 7.9 minutes), excluding 64 participants. This leaves us with 933 respondents, more than 23 times the number of items we administer. We hence comfortably reach the recommended ratio of participants to items of at least 10 (DeVellis 2016).

Remaining participants are on average 37 years old, with a minimum age of 19 and a maximum age of 85. 51% of participants are male, 49% are female, with 1 participant identifying as neither male nor female. 79% of respondents are from the United States, 14% are from India, and the remaining 7% of respondents from 27 different countries. More than 60% have at least a Bachelor's degree as their highest qualification. Table 4.7 in 0 reports the items we test, as well as the item-rest scores for each item and Cronbach's alpha for each of the subscales.

We conduct a factor analysis to determine the dimensionality of the scale. Table 4.8 in 0 shows the Eigenvalues of the principal factor analysis of all items. A test for deciding on the number of factors to extract is the parallel test, which compares the Eigenvalues observed in the data with the Eigenvalues of randomly generated data. One should retain factors until differences between the Eigenvalues in the collected and the randomly generated data become small (DeVellis 2016). Figure 4.1 in 0 shows the plot of the parallel analysis. Parallel analysis suggests a six-factor solution, because Eigenvalues come close to randomly generated data after the sixth factor.

Based on the parallel analysis, we extract six factors. Table 4.9 in 0 shows the rotated factor loadings, using an oblique oblimin rotation. The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.88, indicating meritorious sampling adequacy (DeVellis 2016). While the factor structure is far from clean, few items load on the wrong factor. Only one item, I7, loads above

0.3 on the sixth factor. This result suggests that the five-factor solution suggested by theory is an adequate model for the data after eliminating I7. A possible explanation for why the item loads on a separate factor is that it is the only item that mentions the possibility of harming others in the excess description. The readiness to harm others may have been framed by respondents not as an excess of courage, but as a disregard for the basic claims of others.

Crucially, items L5 and L7 are the only items with cross loadings above 0.3. Many items very clearly load onto one factor only. This dispels the challenge based on the unity of virtue idea described in section 4.3.2, according to which virtues co-vary too strongly to allow for meaningful factor analysis. As indicated in the discussion above, this hypothesis is inconsistent with many items loading on just one factor. We therefore opt for distinguishing a subscale for each of the five intellectual virtues.

We eliminated items loading on a different factor than expected or on several factors, as well as items with loadings below 0.4. For instance, H2 loads primarily on the openness to experience factor, indicating that people have read this item primarily as one about how to relate to new information. Some items do not load above 0.3 on any factor: O1, C1, C5, and H3. The following items fail at least one of these tests: L5, L7, L8; O1, O7; C1, C5, C7, C8; H1, H2, H3; I3, I5, I7. This leaves us with four (C), five (L, H, I), or six (O) items per subscale. By experimenting with different scale lengths based on internal consistency measures and considering the content of the items, we decide to select four items per subscale, aiming for high internal consistency as well as for items that comprehensively sample the domain of the virtues.

We conduct a new factor analysis based on the 20 items selected. Parallel analysis as well as the scree plot suggest a five-factor structure, as illustrated in Figure 4.2 in 0.

Table 4.2 shows the factor loadings of a principal factor analysis after an oblique oblimin rotation.

Table 4.2: Factor loadings exploratory factor analysis 20 best items,

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
I2	0.66				
I3	0.53				
I4	0.58				
I6	0.61				
O2				0.42	
O3				0.56	
O6				0.42	
O8				0.56	
C2		0.56			
C3		0.62			
C4		0.57			
C6		0.52			
H4					0.40
H6					0.48
H7					0.56
H8					0.43
I1			0.47		
I2			0.56		
I4			0.54		
I6			0.55		

Blanks represent abs(loading)<.3

The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.80, which is at the lower end of meritorious sampling adequacy (DeVellis 2016). All items load on the appropriate factor with loadings of at least 0.4, without any cross loadings above 0.3. Moreover, all cross loadings are at least 0.15 smaller than the primary loading of each item.

Table 4.3 shows Cronbach's alpha for the subscales and the scale as a whole, as well as the item-rest correlations of the individual items. Cronbach's alpha for the whole scale at 0.75 is in the desirable range (DeVellis 2016). The alphas for the subscales are between 0.61 for humility and 0.73 for love of knowledge. While internal consistency for love of knowledge and open-mindedness is below 0.7, it should be kept in mind that the subscales are short and designed to sample the whole domain of the respective construct.

Table 4.3: Final item list exploratory factor analysis with internal consistency measures

	Deficit	Virtue	Excess	*Alpha*/ Item-Rest
Love of Knowledge or curiosity is the disposition to actively and purposefully seek knowledge and understanding.				*0.73*
L2	I am not very interested in understanding things.	I want to understand things.	I am excessively interested in understanding things.	0.58
L3	I am not so interested in the reasons why.	I want to know the reasons why.	I am excessively interested in understanding the reasons why.	0.47
L4	I am not particularly curious to learn new things.	I am curious to learn new things.	I get lost in learning new things.	0.51
L6	I do not much enjoy gaining knowledge.	I enjoy gaining knowledge.	I unduly enjoy gaining knowledge.	0.53
Open-mindedness in gathering information is the disposition to take up different standpoints and perspectives in seeking out evidence and being impartial in appraising the reliability of sources of information.				*0.65*
O2	I usually get one or at best a few different perspectives on any given topic.	I get a number of different perspectives on a given topic.	I often get more different perspectives on a topic than I can handle.	0.4
O3	I pay less attention to the views of people I disagree with.	I consider the views of people I disagree with.	I consider the views of people I disagree with extensively even when their views have little merit.	0.48
O6	Loyalty to one's ideas is more important than open-mindedness towards different perspectives.	Open-mindedness towards different perspectives is crucial to overcoming prejudices.	Open-mindedness towards different perspectives is more important than getting to the truth efficiently.	0.36
O8	I am not very open-minded towards viewpoints different from my own.	I am open-minded towards viewpoints different from my own.	I am excessively open-minded towards viewpoints different from my own.	0.46
Conscientiousness in evaluating information is the disposition to evaluate evidence methodically, thoroughly, and carefully.				*0.71*
C2	I tend not to think things through at great length.	I think things through.	I sometimes mull over things until it is too late.	0.48
C3	I make up my mind without much fuss about the many factors that may affect an issue.	I think through the relevant factors before making up my mind.	I think through so many factors that might affect an issue that I sometimes struggle to make up my mind.	0.55
C4	I do not dwell on the pros and the cons when I make up my mind.	I weigh the pros and the cons when I make up my mind.	I often get stuck weighing the pros and cons when I make up my mind.	0.5
C6	I tend to take important decisions on the spot.	I reason carefully and critically before taking important decisions.	I cannot take important decisions unless I am 100% sure.	0.45

Humility in belief formation is the disposition to acknowledge you may be wrong, and to proportion the strength of your beliefs to the strength of your evidence.				*0.61*
H4	I know I am right about most things.	I could be wrong about many things.	I suspect I am wrong about most things.	0.35
H6	I tend to be overconfident in my opinions.	I have a realistic sense of what I know.	I lack confidence in what I know.	0.39
H7	I have strong opinions about issues I know little about.	The more I know about an issue, the more confident I become of my opinions.	I often lack confidence in my opinions even on issues I know a lot about.	0.46
H8	I hold my beliefs firmly even in areas I know little about.	I proportion the strength of my beliefs to the strength of my evidence.	I hardly have any strong beliefs even in areas I know a lot about.	0.35
Intellectual Courage is the disposition to pursue knowledge and understanding even if this may negatively affect your wellbeing.				*0.68*
I1	I am afraid to hold an unpopular opinion.	I am not afraid to adopt an unpopular opinion.	I enjoy holding unpopular opinions for the sake of it.	0.4
I2	I am afraid to ask questions that could make me look stupid.	I am not afraid to ask questions that could make me look stupid.	I often ask questions that could make me look stupid for the fun of it.	0.48
I4	I tend to accept answers I do not understand in order not to appear stupid.	If I do not understand an answer, I keep asking until I understand.	I tend to keep on asking questions for the sake of it.	0.47
I6	I avoid asking questions that might reveal my ignorance.	I ask questions even if they reveal my ignorance.	I do not mind at all about how the questions I ask come across.	0.48
			Overall Alpha 20 items	0.75

The 20 selected items display promising psychometric properties in the exploratory factor analysis, both considering the factor analysis and the internal consistency analysis. We therefore preliminarily select these items to constitute the Intellectual Virtue Scale.

4.5.5 Study 4: Confirmatory Factor Analysis

The purpose of the confirmatory factor analysis is to test whether the factor structure and internal consistency values obtained in the exploratory factor analysis remain stable when the instrument is applied to a new group of people.

We recruit 1,989 respondents on Amazon Mechanical Turk and administer the 20 items identified in the exploratory factor analysis. The items are administered randomly. We also ask participants to answer a number of additional scales for discrimination and divergence analysis, to be discussed in section 4.5.7. We again include two attention checks, which are failed by

983 and 3 respondents, respectively. We exclude the 37 respondents who completed the survey in less than 3 minutes (median completion time: 7.6 minutes). This leaves us with 966 respondents, more than 46 times the number of scale items we seek to test. Remaining participants are between 18 and 81 years old, with an average age of 36. 55% of participants are male, 45% are female, with one participant identifying as neither male nor female. 77% of participants reside in the United States, 18% in India. The remaining 51 participants are from 25 different countries. 63% have obtained at least a Bachelor's degree.

We conduct a factor analysis. Parallel analysis suggests again a five-factor solution, as illustrated in Figure 4.3 in Appendix 11. The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.79, which is 0.01 lower than in the exploratory factor analysis for the same items.

Table 4.10 in Appendix 11 shows the factor loadings for a principal factor analysis of the 20 target items after an oblique oblimin rotation. The results confirm the factor structure in the exploratory data analysis. All items load on the appropriate factor with loadings of at least 0.4, without any cross loadings above 0.3. Moreover, all cross loadings are at least 0.15 smaller than the primary loading of each item. The items with the lowest loadings in the exploratory factor analysis, H4 and O2, have markedly higher loadings in the confirmatory factor analysis. However, the loading of I1 has decreased to 0.4.

Table 4.11 in Appendix 11 shows Cronbach's alpha for the subscales and the scale as a whole, as well as the item-rest correlations of the individual items. Similar to the exploratory factor analysis, Cronbach's alpha for the whole scale is 0.72. The alphas for the subscales are slightly higher than in the exploratory factor analysis, between 0.64 for humility and 0.73 for open-mindedness.

We find that the factor structure of the exploratory factor analysis is replicated in the confirmatory factor analysis. The internal consistency values are all within the acceptable range. We thus confirm the selected items as constituting the Intellectual Virtue Scale.

4.5.6 Descriptive Statistics

We will now describe the intellectual virtues of our sample in the exploratory factor analysis. Table 4.4 shows the summary statistics for the scores of the individual intellectual virtues, obtained by just summing up the values of each of the scores. Appendix 12 contains histograms of each intellectual virtue.

Note that each item is scored from -2 (deficit) to +2 (excess), with the virtuous value at 0. Since there are four items per virtue, the individual virtue scales range from -8 to +8. Ideally virtuous individuals would be at 0 for each of the virtues.

The means are close to 0 for openness, humility, and courage. The mean for conscientiousness, however, is more than half a standard deviation above 0, while the mean for love of knowledge is more than a full standard deviation above 0. These figures show that an average participant sees themselves as tending towards the mid-point between virtue and excess concerning love of knowledge and almost halfway towards that midpoint concerning conscientiousness. Concerning the other three virtues, average participants score close to the virtuous mean.

In order to allow for all five virtues to have an equal impact on the overall intellectual virtue score, we calculate the intellectual virtue score as the sum of the standard scores (z-values) of the individual virtues. Table 4.4 shows the summary statistics for the intellectual virtue score.

Table 4.4: Descriptive statistics intellectual virtues

Virtue	Mean	SD	N	Median
Love of Knowledge	3.20	2.40	965	3
Openness	0.69	2.69	966	0
Conscientiousness	1.62	2.52	965	1
Humility	-0.33	2.17	966	0
Courage	-0.57	2.57	966	0
IVS Score	0.00	2.85	965	-0.16

We conduct an OLS regression with the intellectual virtue score as outcome variable, and the demographic variables collected in the exploratory factor analysis as independent variables. To capture country effects, we created dummies for participants from India and the US, the overwhelming majority of participants. To account for educational differences, we created a dummy capturing all participants that got a BA, MA, or doctorate degree (N=606). Table 4.12 in Appendix 12 reports the results. Only age is significantly associated with the score, at the 1% level. Younger people tend to score slightly higher on the Intellectual Virtue Scale. Sex, country of residence, and whether people were university educated does not have a significant effect on the intellectual virtue score in this sample.

4.5.7 Study 5: Convergence and Divergence Analysis

The purpose of the convergence and divergence analysis is twofold. First, finding positive associations with scales tapping into related constructs provides some support for construct validity, which is the requirement that scales measure the construct they claim to measure. Second, if associations with closely related scales are only small or moderate, this supports the distinctness of the construct one sets out to measure. In our case, we seek to test whether intellectual virtue really is different from related personality traits and moral virtues, as claimed in section 4.2.1.

We use the study for the confirmatory factor analysis to gather data on the convergence and divergence of the Intellectual Virtue Scale and its subscales with related concepts. Hence the

sample is identical to the sample described in section 4.5.5. To investigate the associations with personality, we focus on the two personality traits from the Big Five most closely related to the virtues we test, conscientiousness and open-mindedness. We used items from the International Personality Item Pool measuring the respective personality trait (Johnson 2014; Maples et al. 2014; Donnellan et al. 2006). To investigate associations with scales for moral virtues, we include a number of subscales of the IPIP *Virtue in Action* scale which have a bearing on intellectual virtue: curiosity, love of learning, equity/fairness, valour/bravery, and judgment/open-mindedness (Peterson and Seligman 2004). Finally, we add a professional scepticism (Hurtt 2010) and a critical thinking scale (Sosu 2013). The items of the subscales are listed in Table 4.13 in Appendix 13. We randomly allocate three out of nine scales to each respondent, leading to 320 responses per scale on average.

Table 4.14 in Appendix 13 shows the pairwise correlation between the intellectual virtues and each of the additional scales, including Cronbach's alpha for the measures. As predicted, the Intellectual Virtue Scale is positively correlated to each of the scales we tested. Except for the personality trait of conscientiousness and the equity subscale of the virtue in action scale, all correlations are significant at a 1% level.

The IVS correlates strongest with the critical thinking scale (0.34). The correlation is mostly driven by the items pertaining to love of knowledge and openness, and to a lesser extent by conscientiousness and courage. Humility is weakly and non-significantly negatively correlated with the critical thinking scale.

The second strongest correlation of the Intellectual Virtue Scale is with the curiosity subscale of the Virtue in Action scale "Love of Learning" (0.33). This correlation is mainly driven by the items pertaining to love of knowledge in the IVS (0.49). It is noteworthy that the humility items are significantly and quite strongly negatively correlated with the Virtue in Action "Love of Learning" scale (-0.22). Note also that humility is also negatively correlated with the

intellectual virtue items on love of knowledge, but this negative correlation is small (-0.03) and not significant.

The personality trait openness to experience is the third strongest correlation with the Intellectual Virtue Scale (0.29). The correlation is again mainly driven by love of knowledge (0.35), but also by openness in information gathering (0.22).

At the level of individual virtues, love of knowledge correlated strongest with the Virtue in Action scale "Love of Knowledge," as mentioned above (0.49). Openness correlated strongest with critical thinking (0.31), closely followed by the Virtue in Action subscale "Curiosity" (0.30). Conscientiousness correlates strongest with the Virtue in Action subscale "Judgement" (0.28). Humility's only strong correlations are negative, most strongly with the Virtue in Action subscale "Valour" (-0.27). "Valour" is also the subscale most strongly correlated with intellectual courage (0.34).

We draw two conclusions from this analysis. First, there are no correlations with an unexpected sign. All selected scales are positively correlated with the Intellectual Virtue Scale. This provides evidence that the IVS is construct valid, that is, that the scale measures intellectual virtue. Moreover, none of the correlations is so strong as to indicate that the IVS is tapping into the same constructs as already measured by other scales. Hence, we conclude that intellectual virtue is in fact psychologically distinct both from moral virtue and from personality, as well as from related notions like professional criticism and critical thinking.

It is notable that the correlations of the included scales with conscientiousness and humility are comparatively small, and in a number of cases negative. This result may suggest that none of the included scales focusses specifically on the epistemic stages of processing information and forming beliefs. We are not aware of any scales that relate to this aspect of the epistemic process. The Intellectual Virtue Scale fills this research gap.

4.6 Discussion and Conclusion

The purpose of this study is to develop and validate the Intellectual Virtue Scale. While there are numerous scales to measure personality traits, virtues, and the ability to think critically, we are not aware of a scale that measures intellectual virtues specifically. The Intellectual Virtue Scale fills this gap. The scale has been developed based on leading research on intellectual virtue. Some of the leading researchers on intellectual virtue participated in the expert validation as part of the scale validation.

The resulting 20-item scale has desirable psychometric properties: the scale has a clean factor structure and it shows acceptable levels of internal consistency. Moreover, the convergence and divergence analysis suggests that the IVS is measuring a distinct construct from moral virtue and personality. At the same time, it shows convergence with related scales, providing some support for the construct validity of the scale.

Some limitations of this study warrant acknowledgement. First, we rely on self-assessment and make it obvious to respondents what the socially desirable answer to each item is. As discussed in section 4.3.3, this limits the usefulness of the scale to scenarios where participants have no strong incentives to cast themselves in a positive light. The scale could also be used to rate third parties. Further work could compare the results of the scale when used in self-assessment and when assessment is done by others.

The next step for further validating the scale is to evaluate construct validity. A scale is construct-valid if it is related to outcomes in predictable ways. If the IVS measures intellectual virtue successfully, respondents who score higher should be better at gaining knowledge and understanding. A higher score should therefore lead to better outcomes across domains where knowledge and understanding are key, such as education, economic and financial outcomes,

health, and more. In the next chapter, we will begin this work by investigating the relationship between intellectual virtue and financial outcomes.

Yet another step in further validating the scale is to assess its test-retest validity. A scale has high test-retest validity if the scores of participants change little over time.

Finally, there is more work to be done in developing scales that explore the aspects of intellectual virtue we have excluded so the current scale, including deliberative and other-regarding intellectual virtues.

Appendix 8 Mapping of major taxonomies on the IVS

Table 4.5: Mapping of major taxonomies on the IVS

Roberts and Wood	Intellectual Virtue Scale
Love of Knowledge	Love of Knowledge
Firmness	Intellectual Courage
Courage and Caution	Intellectual Courage
Humility	Humility
Autonomy	Outside of our scope
Generosity	Outside of our scope
Practical Wisdom	Related to all intellectual virtues

Montmarquet	Intellectual Virtue Scale
Epistemic Conscientiousness	Love of Knowledge, aspects of all intellectual virtues
Impartiality	Humility and Open-mindedness
Sobriety	Conscientiousness
Intellectual courage	Intellectual Courage

Zagzebski	Intellectual Virtue Scale
Sensitivity to detail	Conscientiousness
Open-mindedness in collecting and appraising evidence	Open-mindedness
Fairness in evaluating the arguments of others	Conscientiousness
Intellectual humility	Humility
Intellectual perseverance, diligence, care, and thoroughness	Intellectual Courage/Conscientiousness
Adaptability of intellect	Open-mindedness
Being able to recognize reliable authority	Outside of our scope
Insight into persons, problems, theories	Outside of our scope
The social virtues of being communicative, including intellectual candour and knowing your audience	Outside of our scope

Appendix 9 Discrimination Analysis

Table 4.6: Summary of outcomes of the discrimination analysis, omitting the deficit and excess descriptions for each item

Item	Virtue Descriptions	Dominant Virtue	Dominant Virtue Score	Balanced Score	Comprehen sibility
L1	I am excited to learn new things.	L	1.74	0.79	0.88
L2	I want to understand many things.	L	1.89	1.11	0.67
L3	I enjoy taking things apart to see how they work.	L	1.35	-0.41	0.63
L4	I am willing to struggle to figure out things that are important to me.	I	1.53	-0.58	0.65
L5	I seek explanations of things.	L	1.55	-0.05	0.89
L6	I want to know the reasons why.	L	1.79	0.32	0.44
L7	If I hear of something interesting I will try to find out about it.	L	1.74	0.79	0.67
L8	I love to hear about other countries and cultures.	L	1.00	-1.18	-0.18
L9	I am open to exploring new things.	L	1.50	-0.28	0.76
L10	I enjoy gaining knowledge.	L	1.94	1.11	0.76
O1	I am valued by others for my open-mindedness.	O	1.74	0.63	1.00
O2	I check my sources for reliability.	C	1.89	0.44	1.00
O3	I get a number of different perspectives on a given topic.	O	1.88	0.88	0.88
O4	I like to be challenged by people who think differently from me.	O	1.53	-0.68	0.89
O5	I consider the opinions of people I disagree with when making up my mind about controversial topics.	O	1.76	0.24	0.60
O6	I actively look for views I disagree with when trying to make up my mind about something.	O	1.63	0.31	0.86
O7	I often see merit on both sides of the argument.	O	1.06	-1.11	0.67
O8	I sometimes get my news from media outlets that favour viewpoints different from my own.	O	1.67	0.11	0.88
O9	I seek out unfamiliar views and perspectives.	O	1.33	0.11	0.33
O10	I believe that open-mindedness is crucial to avoiding and overcoming prejudices.	O	1.72	-0.11	0.76
O11	If someone told me I've been ignoring their points I would try to rectify that.	O	1.35	-0.55	0.80
O12	There is something to learn from everyone.	O	1.38	0.06	0.87
O13	I am open-minded.	O	1.85	1.00	0.60
C1	I break down difficult problems into small parts.	C	1.58	1.16	0.89
C2	I think things through.	C	1.78	0.72	1.00
C3	I make choices carefully.	C	1.57	0.62	0.78
C4	I make up my mind only after I have taken into account the relevant information.	C	1.65	0.50	0.78
C5	I think through the relevant factors before making up my mind.	C	1.61	0.11	0.65
C6	I weigh the pros and the cons when making up my mind.	C	1.72	0.56	0.78
C7	When I try to make predictions, I estimate how likely an outcome is.	C	1.10	0.20	0.16

C8	When I cannot know for sure, I try to find out how likely things are.	C	0.80	-0.65	0.20
C9	I reason carefully and critically when making important decisions.	C	1.79	0.95	0.89
C10	I regularly check my reasoning for mistakes.	C	1.67	0.28	1.00
C11	If my feelings get in the way of evaluating an argument for some conclusion, I put it aside and come back to it later.	C	1.26	-1.11	0.50
C12	I evaluate information methodically and thoroughly.	C	2.00	1.15	0.90
H1	When I don't know something, I admit it.	H	1.74	0.42	1.00
H2	I adjust my views when conflicting information comes up.	H	1.70	-0.20	0.89
H3	There is nothing wrong with being undecided if there is little information to go on.	H	1.39	-0.39	0.76
H4	I could be wrong about many things.	H	1.95	1.05	1.00
H5	I rethink my position when new information comes up.	H	1.44	-0.56	1.00
H6	It is easy for me to concede I am wrong.	H	1.78	0.83	0.76
H7	I do not exaggerate how much I know.	H	1.53	0.68	0.76
H8	The more I know about an issue, the more confident I become of my opinions.	H	1.68	0.89	0.89
H9	I reconsider my views when reflection suggests I may be wrong.	H	1.40	-0.40	0.58
H10	I proportion the strength of my beliefs to the strength of my evidence.	H	1.79	0.26	0.71
I1	I am not afraid to adopt an unpopular opinion.	I	1.50	0.60	1.00
I2	I am not afraid to ask 'stupid questions'.	I	1.22	-0.67	0.65
I3	I tend to speak up in the face of strong opposition.	I	1.05	0.16	0.56
I4	I am not afraid to try new ways of thinking.	O	1.11	-1.17	0.18
I5	I keep asking questions until I understand the answer.	L	1.26	-0.58	0.76
I6	I pursue the truth even if it might be uncomfortable for me.	I	1.83	0.28	0.63
I7	I ask questions even if they reveal my ignorance.	I	1.33	-0.89	0.67
I8	I stick to my beliefs in spite of criticism as long as I am not convinced by the criticism.	H	1.26	-0.42	0.89
I9	To help the debate, I would give reasons in favour of an unpopular opinion, even if it is not my own.	O	1.16	-0.63	0.79
I10	I speak my mind freely even at some personal risk.	I	1.57	1.19	0.81

Appendix 10 Exploratory Factor Analysis

Table 4.7: Item pool and internal consistency measures exploratory factor analysis

#	Deficit	Virtue	Excess	Alpha/ Item-Rest
Love of Knowledge or curiosity is the disposition to actively and purposefully seek knowledge and understanding.				0.78
L1	I am not very interested in learning new things.	I am excited to learn new things.	I am so excited to learn new things that other commitments might suffer.	0.55
L2	I am not very interested in understanding things.	I want to understand things.	I am excessively interested in understanding things.	0.55
L3	I am not so interested in the reasons why.	I want to know the reasons why.	I am excessively interested in understanding the reasons why.	0.49
L4	I am not particularly curious to learn new things.	I am curious to learn new things.	I get lost in learning new things.	0.59
L5	I like to stick to what I know when solving a problem.	I am open to learn new things when solving a problem.	I care more about learning something new than finding the best solution to a problem.	0.45
L6	I do not much enjoy gaining knowledge.	I enjoy gaining knowledge.	I unduly enjoy gaining knowledge.	0.51
L7	I am not very much concerned about other countries and cultures.	I love to hear about other countries and cultures.	I sometimes spend too much time learning about other countries and cultures.	0.39
L8	I have no inclination to learn how things work by taking them apart.	I like to learn how things work by taking them apart.	I like to learn how things work by taking them apart regardless of the consequences.	0.38
				0.73
Open-mindedness in gathering information is the disposition to take up different standpoints and perspectives in seeking out evidence and being impartial in appraising the reliability of sources of information.				
O1	I sometimes ignore sources of information that are potentially relevant to my purpose (e.g. people or media outlets).	I choose an appropriate range of sources of information relevant to my purpose.	I sometimes choose a wide variety of sources of information without thinking too much about their relevance for my purpose.	0.31
O2	I usually get one or at best a few different perspectives on any given topic.	I get a number of different perspectives on a given topic.	I often get more different perspectives on a topic than I can handle.	0.47
O3	I pay less attention to the views of people I disagree with.	I consider the views of people I disagree with.	I consider the views of people I disagree with extensively even when their views have little merit.	0.55
O4	I pay little attention to viewpoints I disagree with.	I actively look for views I disagree with.	I tend to get lost when looking for views I disagree with.	0.47
O5	I get most of my news from media outlets that favour viewpoints I agree with.	I get a good part of my news from media outlets that favour viewpoints I disagree with.	I spend a lot of time getting news from media outlets that favour viewpoints I disagree with, even when their viewpoints have little merit.	0.41
O6	Loyalty to one's ideas is more important than open-mindedness towards different perspectives.	Open-mindedness towards different perspectives is crucial to overcoming prejudices.	Open-mindedness towards different perspectives is more important than getting to the truth efficiently.	0.38

O7	Few people are really worth listening to.	There is something to learn from everyone.	Everyone's perspective should always get equal attention.	0.33
O8	I am not very open-minded towards viewpoints different from my own.	I am open-minded towards viewpoints different from my own.	I am excessively open-minded towards viewpoints different from my own.	0.5
				0.7

Conscientiousness in evaluating information is the disposition to evaluate evidence methodically, thoroughly, and carefully.

C1	I often do not break down difficult problems in small parts.	I frequently break down difficult problems into small parts.	I tend to lose sight of my main problem because I get lost in details.	0.28
C2	I tend not to think things through at great length.	I think things through.	I sometimes mull over things until it is too late.	0.48
C3	I make up my mind without much fuss about the many factors that may affect an issue.	I think through the relevant factors before making up my mind.	I think through so many factors that might affect an issue that I sometimes struggle to make up my mind.	0.51
C4	I do not dwell on the pros and the cons when I make up my mind.	I weigh the pros and the cons when I make up my mind.	I often get stuck weighing the pros and cons when I make up my mind.	0.47
C5	When I make a prediction, I am not interested in probability, but in whether an outcome will happen or not.	When I make a prediction, I guess the probability that an outcome will happen.	I seldom make a prediction, because I find it difficult to deal with uncertainty.	0.23
C6	I tend to take important decisions on the spot.	I reason carefully and critically before taking important decisions.	I cannot take important decisions unless I am 100% sure.	0.45
C7	I sometimes forget to check my reasoning for mistakes.	I regularly check my reasoning for mistakes.	I tend to obsess about avoiding mistakes in my reasoning.	0.39
C8	I often evaluate information without much of a system.	I evaluate information systematically.	I am excessively systematic in evaluating information.	0.31
				0.64

Humility in belief formation is the disposition to acknowledge you may be wrong, and to proportion the strength of your beliefs to the strength of your evidence.

H1	I very rarely realize when I know less than I should.	I have a good sense of how much I know.	I tend to underestimate how much I know.	0.27
H2	I tend to hold on to my views even if conflicting information comes up.	I adjust my views in the light of new information.	I tend to overreact to new information.	0.29
H3	Suspending judgment is a sign of weakness.	There is nothing wrong with suspending judgment if there is little information to go on.	It is best to suspend judgment because it avoids error.	0.17
H4	I know I am right about most things.	I could be wrong about many things.	I suspect I am wrong about most things.	0.34
H5	I very rarely recognize that I am wrong.	It is easy for me to recognize when I am wrong.	I am easily led to believe that I am wrong.	0.39
H6	I tend to be overconfident in my opinions.	I have a realistic sense of what I know.	I lack confidence in what I know.	0.4
H7	I have strong opinions about issues I know little about.	The more I know about an issue, the more confident I become of my opinions.	I often lack confidence in my opinions even on issues I know a lot about.	0.42
H8	I hold my beliefs firmly even in areas I know little about.	I proportion the strength of my beliefs to the strength of my evidence.	I hardly have any strong beliefs even in areas I know a lot about.	0.39
				0.77

Intellectual Courage is the disposition to pursue knowledge and understanding even if this may negatively affect your wellbeing.

I1	I am afraid to hold an unpopular opinion.	I am not afraid to adopt an unpopular opinion.	I enjoy holding unpopular opinions for the sake of it.	0.49
I2	I am afraid to ask questions that could make me look stupid.	I am not afraid to ask questions that could make me look stupid.	I often ask questions that could make me look stupid for the fun of it.	0.54
I3	I abandon opinions if my environment disapproves of them.	I entertain opinions that I find plausible even if my environment disapproves of them.	I endorse opinions my environment disapproves of for the sake of it.	0.37
I4	I tend to accept answers I do not understand in order not to appear stupid.	If I do not understand an answer, I keep asking until I understand.	I tend to keep on asking questions for the sake of it.	0.51
I5	I sometimes sacrifice pursuing the truth when it is uncomfortable for me.	I pursue the truth even if it might be uncomfortable for me.	I pursue the truth even if I know doing so will do more harm than good.	0.41
I6	I avoid asking questions that might reveal my ignorance.	I ask questions even if they reveal my ignorance.	I do not mind at all about how the questions I ask come across.	0.49
I7	I don't pursue knowledge at the risk of personal costs.	I pursue knowledge even at the risk of personal costs.	I pursue knowledge even at the risk of harming others.	0.41
I8	I don't speak my mind freely when there might be negative results for me.	I speak my mind freely even at some personal risk.	I speak my mind freely even at the risk of causing serious harm to others.	0.55

Table 4.8: Eigenvalues of Exploratory Principal Factor Analysis all items

Factor	Eigenvalue	Difference
Factor1	5.85	3.37
Factor2	2.48	1.05
Factor3	1.43	0.39
Factor4	1.04	0.27
Factor5	0.77	0.27
Factor6	0.50	0.03
Factor7	0.47	0.16
Factor8	0.31	0.04
Factor9	0.27	0.03
Factor10	0.24	0.03

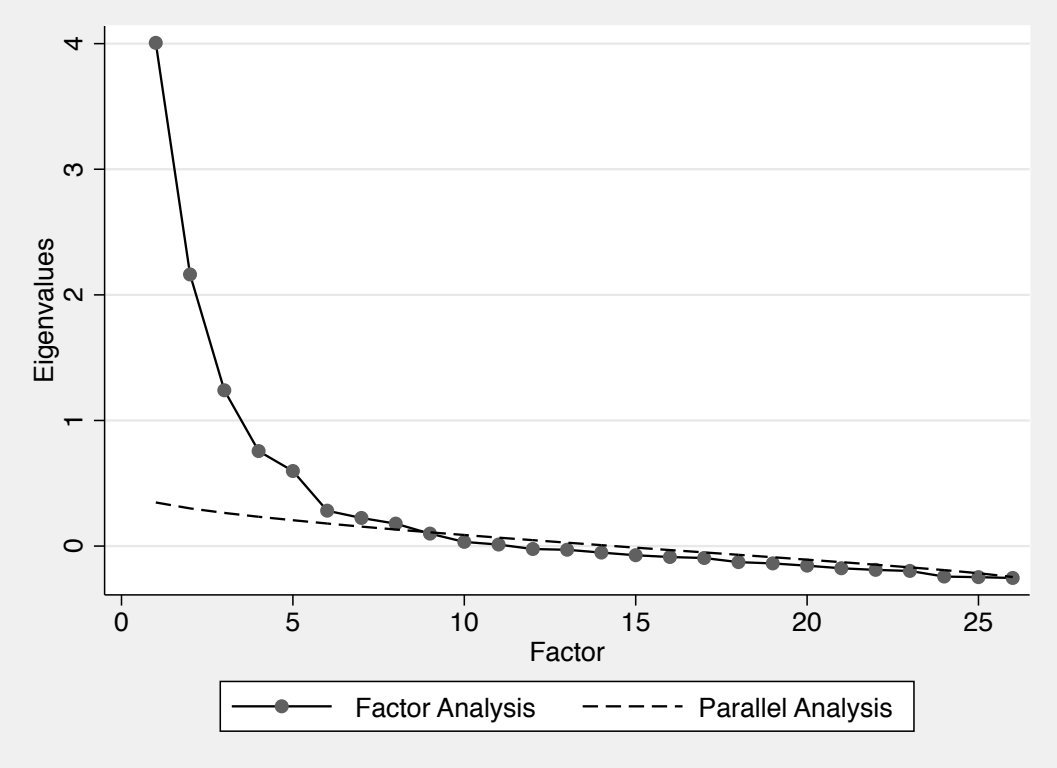

Figure 4.1: Parallel analysis of Exploratory Principal Factor Analysis all items

Table 4.9: Factor loading exploratory factor analysis all items

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
L1	0.60					
L2	0.63					
L3	0.49					
L4	0.66					
L5	0.39	0.30				
L6	0.63					
L7	0.34	0.33				
L8	0.31					
O1						
O2		0.45				
O3		0.60				
O4		0.51				
O5		0.42				
O6		0.42				
O7		0.39				
O8		0.58				
C1						
C2				0.55		
C3				0.59		
C4				0.58		
C5						
C6				0.54		
C7				0.37		
C8				0.31		
H1					0.30	
H2		0.31				
H3						
H4					0.41	
H5					0.41	
H6					0.54	
H7					0.55	
H8					0.42	
I1			0.42			
I2			0.67			
I3			0.31			
I4			0.56			
I5			0.36			
I6			0.66			
I7						0.39
I8			0.50			

Blanks represent abs(loading)<.3

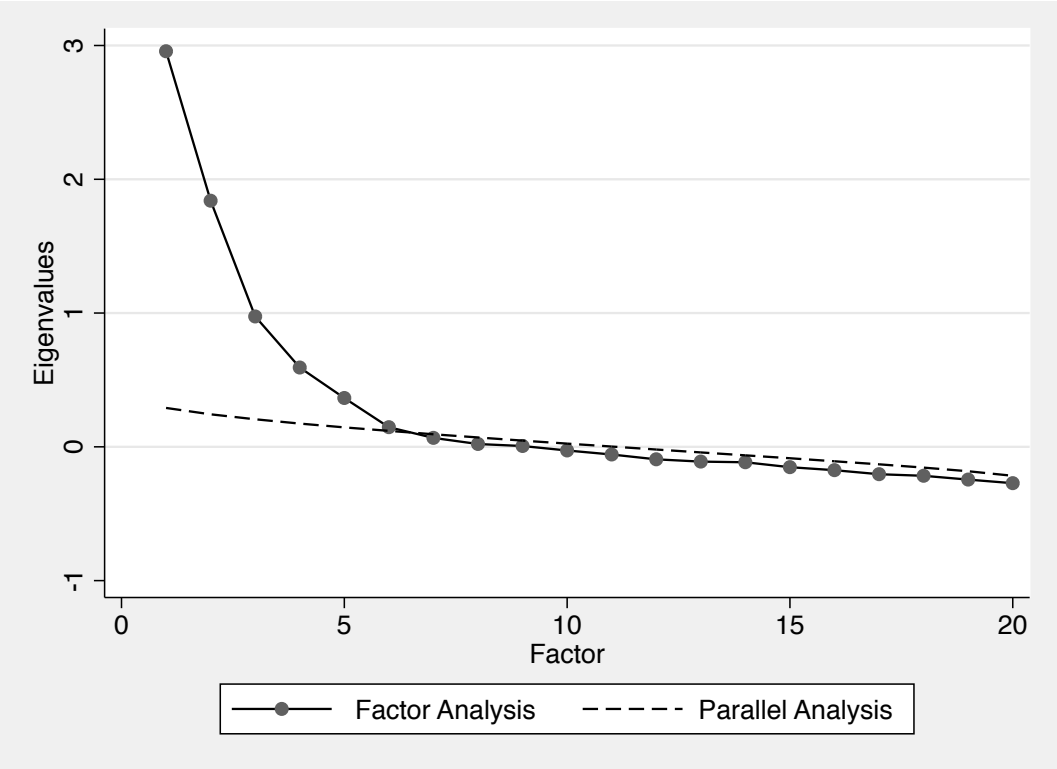

Figure 4.2: Parallel analysis for 20 best items in the exploratory factor analysis

Appendix 11 Confirmatory Factor Analysis

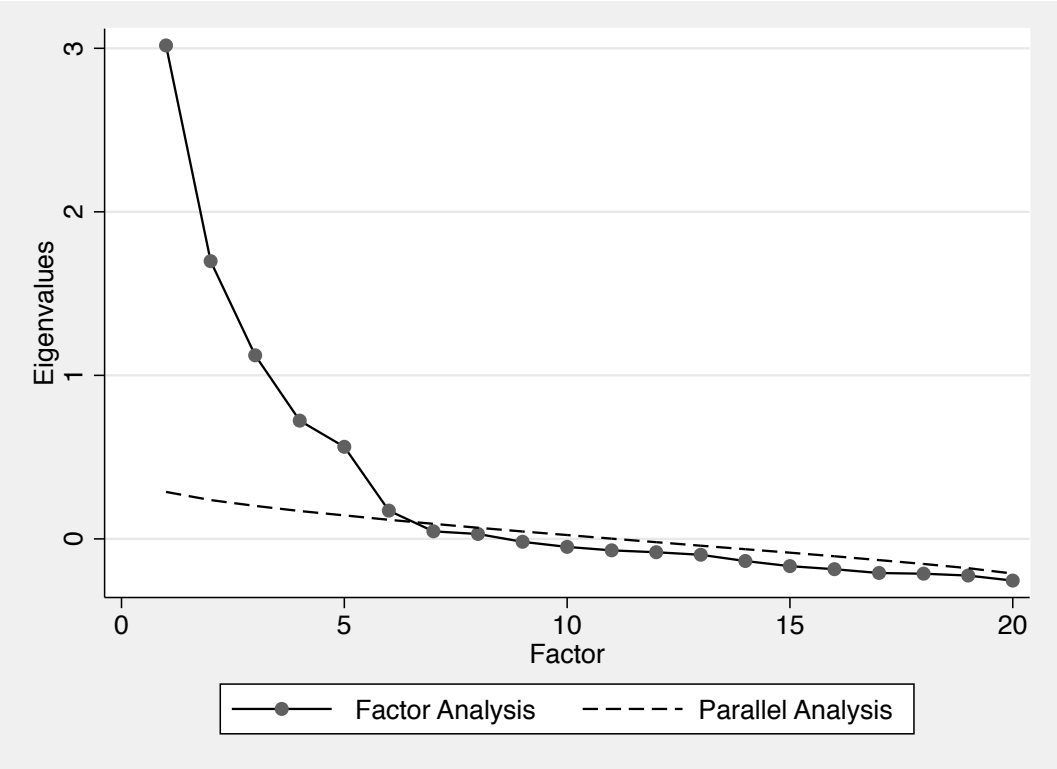

Figure 4.3: Parallel analysis for Confirmatory Factor Analysis

Table 4.10: Factor loadings confirmatory factor analysis

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
L2	0.70				
L3	0.65				
L4	0.34				
L6	0.58				
O2		0.48			
O3		0.65			
O6		0.48			
O8		0.69			
C2				0.51	
C3				0.61	
C4				0.56	
C6				0.49	
H4					0.53
H6					0.54
H7					0.55
H8					0.44
I1			0.40		
I2			0.65		
I4			0.54		
I6			0.61		

Blanks represent abs(loading)<.3

Table 4.11: Internal consistency confirmatory factor analysis

Name	Alpha/Item-Rest
Love of Knowledge	*0.7*
L2	0.59
L3	0.55
L4	0.29
L6	0.51
Open-mindedness in gathering information	*0.73*
O2	0.47
O3	0.58
O6	0.42
O8	0.61
Conscientiousness in evaluating information	*0.68*
C2	0.44
C3	0.52
C4	0.47
C6	0.68
Humility in belief formation	*0.64*
H4	0.41
H6	0.44
H7	0.46
H8	0.36
Intellectual Courage	*0.68*
I1	0.32
I2	0.56
I4	0.46
I6	0.5
Alpha whole scale	*0.72*

Appendix 12 Descriptive Statistics Exploratory Factor Analysis

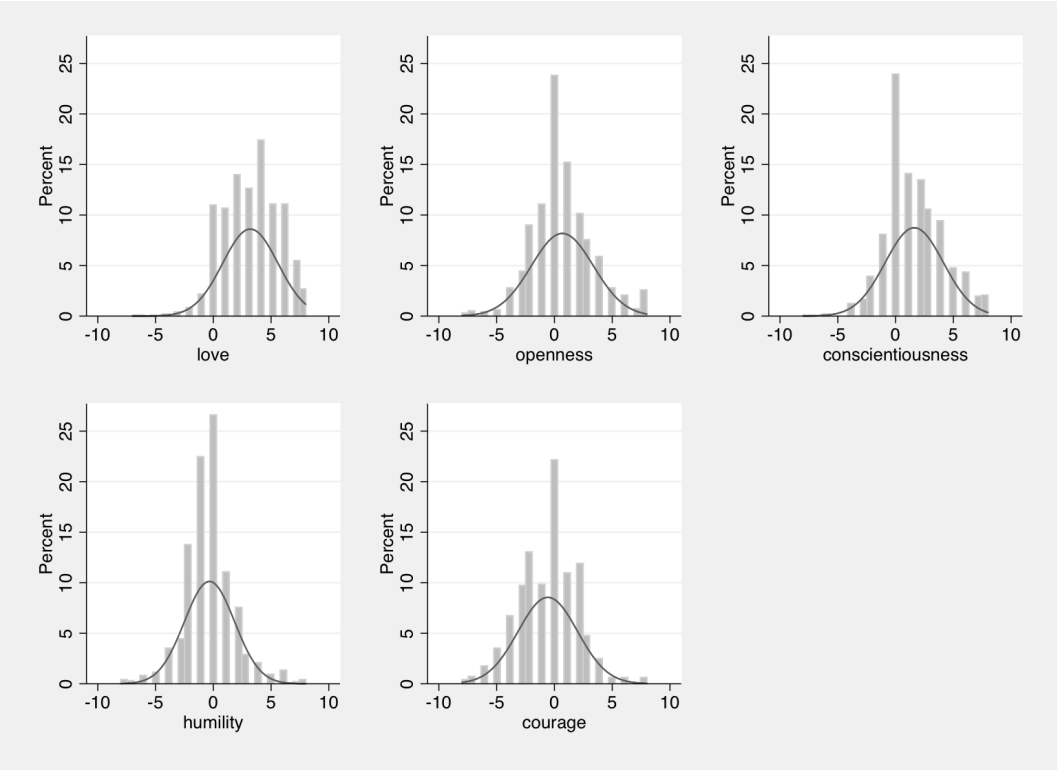

Figure 4.4: Histograms of intellectual virtue score for individual virtues overlaid with plot of normal distribution

Table 4.12: Regression of demographic variables on intellectual virtue score.

	(1)
Age	-0.030***
	(0.008)
Female	-0.055
	(0.187)
Uni	-0.070
	(0.198)
India	0.393
	(0.455)
USA	-0.224
	(0.417)
Constant	1.246**
	(0.492)
Observations	961
R-squared	0.027

Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix 13 Convergence/Divergence Analysis

Table 4.13: Items of scales for convergence and discrimination analysis

IPIP VIA Curiosity (VC)
Find the world a very interesting place.
Am never bored.
Am always busy with something interesting.
Am excited by many different activities.
Can find something of interest in any situation.
Think that my life is extremely interesting.
Love to hear about other countries and cultures.
Will try anything once.
Love to travel to places that I have never been before.
Am not all that curious about the world. (R)
Find it difficult to entertain myself. (R)

IPIP VIA Love of Learning (VL)
Am thrilled when I learn something new.
Look forward to the opportunity to learn and grow.
Am a true life-long learner.
Read all the time.
Consult the library or the Internet immediately if I want to know something.
Do not like to learn new things. (R)
Do not like to visit museums. (R)
When learning something new it is easy for me to spend a long amount of time learning it.
Like to spend time learning new things that do not have anything to do with my studies or work.
My friends and family would say that I am interested in lots of different things.

IPIP VIA Equity/Fairness (VE)
Admit when I am wrong.
Treat all people equally.
Am a good listener.
Believe that everyone's rights are equally important.
Give everyone a chance.
Am committed to principles of justice and equality.
Refuse to take credit for work I haven’t done.
No one deserves to be discriminated against because of the colour of their skin.
Try to act fairly in all situations.
Think that everyone should be responsible for their own behaviours.
Help people even when I do not want to, because it is the right thing to do.
Think that everyone should get a fair share.
Take advantage of others. (R)
Know people whose opinions are simply not worth listening to. (R)

IPIP VIA Valour/Bravery (VV)
Have taken frequent stands in the face of strong opposition.
Do not hesitate to express an unpopular opinion.
Call for action while others talk.
Can face my fears.
Speak up in protest when I hear someone say mean things.
Am a brave person.
Have overcome pain and disappointment.
Avoid dealing with uncomfortable emotions.
Avoid dealing with awkward situations.
Do not stand up for my beliefs. (R)
Do not speak my mind freely when there might be negative results. (R)
Can think of a time(s) in my life where I was very brave.
Am able to do what I should do, even when I feel scared.

IPIP VIA Judgment/Open-Mindedness (VJ)
Try to identify the reasons for my actions.
Make decisions only after I have all of the facts.
Am valued by others for my objectivity.
Am a firm believer in thinking things through.
Weigh the pros and the cons.
Am valued by my friends for my good judgment.
Do not think about different possibilities when making decisions. (R)
Do not tend to think things through critically. (R)
Do not think about more possibilities than the one I like first. (R)
Am approached often by people who want help, advice, or guidance with their problems.
Think that changing important personal beliefs is often necessary to grow as a person.

IPIP NEO Conscientiousness (NC)
Am always prepared.
Pay attention to details.
Get chores done right away.
Carry out my plans.
Make plans and stick to them.
Waste my time. (R)
Find it difficult to get down to work. (R)
Do just enough work to get by. (R)
Don't see things through. (R)
Shirk my duties. (R)

IPIP NEO Openness to Experience (NO)
Believe in the importance of art.
Have a vivid imagination.
Tend to vote for liberal political candidates.
Carry the conversation to a higher level.
Enjoy hearing new ideas.
Am not interested in abstract ideas. (R)
Do not like art. (R)
Avoid philosophical discussions. (R)
Do not enjoy going to art museums. (R)
Tend to vote for conservative political candidates. (R)

Professional Scepticism (PS)
I often accept other people's explanations without further thought.
I feel good about myself.
I wait to decide on issues until I can get more information
The prospect of learning excites me.
I am interested in what causes people to behave in the way that they do.
I am confident of my abilities.
I often reject statements unless I have proof that they are true.
Discovering new information is fun.
I take my time when making decisions.
I tend to immediately accept what other people tell me.
Other people's behaviour does not interest me (R)
I am self-assured.
My friends tell me that I usually question things that I see or hear.
I like to understand the reason for other people's behaviour.
I think that learning is exciting.
I usually accept things I see, read, or hear at face value. (R)
I do not feel sure of myself.
I usually notice inconsistencies in explanations.
Most often I agree with what others in my group think. (R)
I dislike having to make decisions quickly.
I have confidence in myself.
I do not like to decide until I have looked at all of the readily available information.
I like searching for knowledge.
I frequently question things that I see or hear.
It is easy for other people to convince me. (R)
I seldom consider why people behave in a certain way. (R)
I like to ensure that I've considered most available information before making a decision.
I enjoy trying to determine if what I read or hear is true.
I relish learning.
The actions people take and the reasons for those actions are fascinating.

Critical Thinking Disposition Scale (CT)
I usually try to think about the bigger picture during a discussion.
I often use new ideas to shape (modify) the way I do things.
I use more than one source to find out information for myself.
I am often on the lookout for new ideas.
I sometimes find a good argument that challenges some of my firmly held beliefs.
It's important to understand other people's viewpoint on an issue.
It is important to justify the choices I make.
I often re-evaluate my experiences so that I can learn from them.
I usually think about the wider implications of a decision before taking action.
I usually check the credibility of the source of information before making judgements.
I often think about my actions to see whether I could improve them.

Table 4.14: Pairwise correlation coefficients for IVS and related scales

	IVS	IVS_love	IVS_openness	IVS_conscientiousness	IVS_humility	IVS_courage	VC	VL	VE	VV	VJ	NC	NO	PS	CT
IVS	alpha: 0.72 *965 obs.*														
IVS_love	0.63 *(0.00)*	alpha: 0.70 *965 obs.*													
IVS_openness	0.68 *(0.00)*	0.37 *(0.00)*	alpha: 0.73 *966 obs.*												
IVS_conscientiousness	0.58 *(0.00)*	0.23 *(0.00)*	0.19 *(0.00)*	alpha: 0.68 *966 obs.*											
IVS_humility	0.44 *(0.00)*	-0.03 *(0.36)*	0.07 *(0.02)*	0.24 *(0.00)*	alpha: 0.64 *966 obs.*										
IVS_courage	0.52 *(0.00)*	0.22 *(0.00)*	0.29 *(0.00)*	0.00 *(0.97)*	-0.03 *(0.30)*	alpha: 0.68 *966 obs.*									
VC	0.22 *(0.00)*	0.33 *(0.00)*	0.30 *(0.00)*	0.02 *(0.68)*	-0.22 *(0.00)*	0.19 *(0.00)*	alpha: 0.82 *319 obs.*								
VL	0.33 *(0.00)*	0.49 *(0.00)*	0.20 *(0.00)*	0.02 *(0.67)*	-0.04 *(0.46)*	0.25 *(0.00)*	0.74 *(0.00)*	alpha: 0.83 *320 obs.*							
VE	0.06 *(0.26)*	0.07 *(0.21)*	0.15 *(0.01)*	-0.05 *(0.42)*	-0.03 *(0.59)*	0.03 *(0.57)*	0.58 *(0.00)*	0.34 *(0.00)*	alpha: 0.84 *319 obs.*						
VV	0.19 *(0.00)*	0.31 *(0.00)*	0.23 *(0.00)*	-0.03 *(0.63)*	-0.27 *(0.00)*	0.34 *(0.00)*	0.60 *(0.00)*	0.48 *(0.00)*	0.27 *(0.02)*	alpha: 0.85 *325 obs.*					
VJ	0.25 *(0.00)*	0.25 *(0.00)*	0.18 *(0.00)*	0.28 *(0.00)*	-0.07 *(0.20)*	0.08 *(0.15)*	0.63 *(0.00)*	0.44 *(0.00)*	0.36 *(0.00)*	0.34 *(0.00)*	alpha: 0.78 *321 obs.*				
NC	0.07 *(0.24)*	0.11 *(0.04)*	0.09 *(0.09)*	-0.12 *(0.03)*	-0.13 *(0.02)*	0.21 *(0.00)*	0.61 *(0.00)*	0.37 *(0.00)*	0.44 *(0.00)*	0.53 *(0.00)*	0.35 *(0.00)*	alpha: 0.88 *323 obs.*			
NO	0.29 *(0.00)*	0.35 *(0.00)*	0.22 *(0.00)*	0.07 *(0.19)*	-0.02 *(0.74)*	0.17 *(0.00)*	0.28 *(0.01)*	0.51 *(0.00)*	0.46 *(0.00)*	0.19 *(0.07)*	0.26 *(0.04)*	0.14 *(0.21)*	alpha: 0.82 *318 obs.*		
PS	0.17 *(0.00)*	0.39 *(0.00)*	0.09 *(0.12)*	0.01 *(0.90)*	-0.12 *(0.03)*	0.13 *(0.02)*	0.58 *(0.00)*	0.67 *(0.00)*	0.59 *(0.00)*	0.62 *(0.00)*	0.68 *(0.00)*	0.46 *(0.00)*	0.53 *(0.00)*	alpha: 0.86 *322 obs.*	
CT	0.34 *(0.00)*	0.38 *(0.00)*	0.31 *(0.00)*	0.15 *(0.01)*	-0.02 *(0.76)*	0.14 *(0.01)*	0.59 *(0.00)*	0.58 *(0.00)*	0.52 *(0.00)*	0.49 *(0.00)*	0.63 *(0.00)*	0.23 *(0.05)*	0.33 *(0.00)*	0.60 *(0.00)*	alpha: 0.83 *323 obs.*

Note: Alphas and number of observations for each of the scales in the diagonal. Numbers in brackets are p-values.

5 Do Intellectual Virtues Matter for Financial Literacy?

5.1 Introduction

Research on financial literacy has shown that knowledge and understanding of financial concepts and products is associated with better financial decisions. For instance, financial literacy is associated with better preparedness for retirement (Van Rooij, Lusardi, and Alessie 2011a), safer mortgages (Van Ooijen and Van Rooij 2016), and higher rates of stock-market participation (Van Rooij, Lusardi, and Alessie 2011b).

The importance of financial literacy raises the question of which factors support the acquisition of financial literacy. Researchers are sometimes quick to assume that financial education is the only viable way of boosting financial literacy, even though the impact evaluations of educational interventions to boost financial knowledge have been mixed (Lusardi and Mitchell 2014). An area that has received little attention in the literature on financial literacy is the role of personal characteristics in becoming financially literate. Which intellectual qualities promote the formation of financial literacy? We start addressing this research gap by investigating whether *intellectual virtues* support gaining knowledge and understanding about finance. Moreover, we explore whether intellectual virtues lead to a more reflective and conscientious approach to financial decision making.

Intellectual virtues are qualities of individuals that support processing information and dealing with information conscientiously (Morton 2012; Alfano et al. 2017; De Bruin 2013; Peterson and Seligman 2004). We focus on five intellectual virtues: love of knowledge, openness in gathering information, conscientiousness in processing information, humility in belief

formation, and intellectual courage. We assess these virtues using a novel measurement instrument, the *Intellectual Virtue Scale* (IVS), introduced in chapter 4.

We find that intellectually virtuous people are more financially literate. We also demonstrate that intellectually virtuous people deal more reflectively and conscientiously with financial matters. In particular, intellectually virtuous people display greater self-awareness about their financial knowledge or lack thereof, and are more likely to compare different financial advisors.

These results have implications for policies to promote financial literacy. To date there is little evidence that financial literacy can be effectively taught directly (Fernandes, Lynch, and Netemeyer 2014; Lusardi 2008). This motivates searching for alternative ways of promoting financial literacy. Intellectual virtues are acquired traits which can be trained and fostered (Battaly 2006; Baehr 2013). Fostering intellectual virtue may thus provide a route to improve financial decision making. On a policy level, improving financial literacy across the population may be achieved by making the development of intellectual virtue a priority in the education system.

The chapter is structured as follows. Section 5.2 relates our contribution to existing literature on intellectual virtue and financial literacy and articulates our hypotheses. Section 5.3 describes how we measure intellectual virtue and the outcome variables. Section 5.4 presents and discusses regression results. Section 5.5 discusses strengths and limitations of the current investigation, and points to opportunities for further research.

5.2 The Intellectual Virtue Scale and Financial Decision Making

This study brings together two fields of research that have developed independently of each other and have not been linked so far. The financial literacy literature is one strand of research (Cox, Brounen, and Neuteboom 2015; Lusardi and Mitchell 2007; Hilgert, Hogarth, and

Beverly 2003; Duca and Kumar 2014; Alessie, Rooij, and Lusardi 2011). The research on financial literacy has been conducted by economists with an emphasis on relating financial literacy to economic outcomes. Financial literacy is measured with questions on financial numeracy and knowledge about financial concepts. While this research has amply shown that financial literature is associated with better financial outcomes, the determinants of gaining financial knowledge and understanding have received little attention so far. One study has found that wealth plays only a minor role in explaining differences in financial literacy (Monticone 2010). Another study finds that motivation to become financially literate explains some of the variance in financial literacy scores after participants went through a financial education program (Mandell and Klein 2007).

We seek to connect the literature on financial literacy with research on intellectual virtue. Intellectual virtues are acquired character traits that support gaining knowledge and understanding (Zagzebski 1996; Montmarquet 1993; Roberts and Wood 2007; Morton 2012; Fricker 2007; De Bruin 2013; Baehr 2011; 2006; Fairweather and Zagzebski 2001). Research on intellectual virtue has been conducted mainly in philosophy, which has led to an emphasis of conceptual and theoretical investigations of intellectual virtues (Battaly 2008). Only recently have researchers started to investigate the empirical underpinnings of intellectual virtue (Fairweather and Flanagan 2014). There has also been interest by psychologists into some aspects of intellectual virtue (Peterson and Seligman 2004; Tetlock et al. 2000; Lerner and Tetlock 1999; Tetlock 1983, 2005).

The finding by Mandell and Klein (mentioned above) that motivation explains differences in financial literacy suggests that intellectual qualities more broadly may affect financial literacy. Intellectual virtues include love of knowledge or curiosity, which is related to motivation, but also assesses a range of other intellectual qualities that may support the acquisition of financial knowledge and understanding. We are concerned with the following five intellectual virtues:

Love of Knowledge or curiosity is the disposition to actively and purposefully seek knowledge and understanding. Love of knowledge supports and enables the exercise of the other intellectual virtues by motivating their bearers to pursue knowledge and understanding.

Open-mindedness in gathering information is the disposition to take up different standpoints and perspectives in seeking out evidence and being impartial in appraising the reliability of sources of information. Open-mindedness relates to the information-gathering phase of processing information, concerning the selection of evidence, sources, and interlocutors.

Conscientiousness in evaluating information is the disposition to evaluate evidence methodically, thoroughly, and carefully. Conscientiousness relates to the evaluation of information, pertaining to acknowledging, comparing, and weighing information according to their relevance and merits.

Humility in belief formation is the disposition to acknowledge you may be wrong, and to proportion the strength of your beliefs to the strength of your evidence. Humility pertains to the formation and revision of beliefs, including striking the right balance between over- and under-confidence.

Intellectual Courage is the disposition to pursue knowledge and understanding even if this may negatively affect your wellbeing. Similar to love of knowledge, intellectual courage supports and enables the exercise of other intellectual virtues by fostering resilience in dealing with risks and fears in acquiring knowledge and understanding.

How are intellectual virtues relevant to financial decision making? The Intellectual Virtue Scale evaluates traits related to motivating people to learn relevant information, and to be more competent in dealing with information. Therefore, we expect intellectually virtuous people to have more financial knowledge and understand financial concepts better. Moreover, some intellectual virtues, in particular humility and intellectual courage, require the ability to reflect

on the state of one's beliefs and the strength of the justification of these beliefs. We therefore expect intellectually virtuous people to be better aware of the limits of their knowledge and to be more reflective in making financial decisions. As a result, we expect intellectually virtuous people to score higher on traditional measures of financial literacy and to display higher self-awareness of the extent of their financial knowledge. We expect that these behaviours lead intellectually virtuous people to make financial decisions more diligently.

The expectation that intellectually virtuous people are more financially literate is a direct consequence of what intellectual virtues are, namely stable dispositions supporting people in coming to know and understanding relevant information (Zagzebski 1996). While finance is perhaps not intrinsically interesting for many people, financial decisions are critical for the financial wellbeing of households in modern developed societies like the Netherlands (Campbell 2006). We expect that intellectually virtuous people are more likely to take an interest in finance and thereby improve their financial literacy. We therefore expect that intellectually virtuous people are more financially literate.

The expectation that intellectual virtue influences the accuracy of the self-assessment of people about their financial knowledge is also grounded in the nature of intellectual virtue. Exercising conscientiousness, humility, and intellectual courage all require us to deal with information diligently (De Bruin 2014). Diligence involves reflecting critically on whether one's state of knowledge in a certain domain is sufficient to take consequential decisions based on that knowledge (Hawthorne and Stanley 2008). Hence the ability to monitor one's state of knowledge in different domains is an important dimension of intellectual knowledge (Baehr 2011). Since some financial decisions by households have major consequences for decades, we expect that intellectually virtuous people will be good at assessing the state of their knowledge in this domain, as measured by their estimate of how many questions they answered correctly in financial literacy questionnaires. A more accurate self-assessment puts people in a

better position to avoid costly financial mistakes due to over- or under-confidence (Kramer 2016). We therefore expect that intellectually virtuous people have a more accurate self-assessment of their financial knowledge.

Finally, we expect that intellectually virtuous people are more conscientious in selecting a financial advisor as measured by whether they compare different financial advisors before making a decision. Comparing financial advisors is an instance of conscientious financial decision making because the quality of financial advisors differs (Mullainathan, Noeth, and Schoar 2012). Previous research has investigated the relationship between financial literacy and advice seeking (Kramer 2016; Calcagno and Monticone 2015; Christine T. Ennew 1992), without finding a robust link. But the impact of intellectual virtue on financial advice seeking has been neglected so far. We expect that intellectually virtuous people are more likely to compare advisors rather than work with the first best candidate. In particular, comparing financial advisors is an exercise of the virtues of openness in information gathering and conscientiousness in information processing. Hence, we expect that intellectually virtuous people are more likely to compare different financial advisors.

5.3 The Data

5.3.1 The DNB Household Survey

We designed a questionnaire including measures of financial literacy, the Intellectual Virtue Scale, and questions about financial advice. The questionnaire was fielded in the CentERpanel over two weeks in June 2017. The CentERpanel is an Internet based panel of over 2,000 households administrated by CentERdata at Tilburg University and sponsored by the Dutch Central Bank. The panel is representative of the Dutch population. Questionnaires are administered online. Panel members without internet access receive equipment that enables them to participate through their television. Both the head of the household and any partner

aged 20 or above are interviewed. 2,126 household members completed the survey (1,746 households). 69% of respondents have a residential mortgage on their property (1,443 respondents).

Our questionnaire is combined with background information from the 2016 Dutch Household Survey (DHS). The DHS is an annual panel study which collects detailed information on the economic situation of households and psychological traits. The DHS consists of six modules. We were able to merge our survey with 1,174 people who completed the survey. Demographic information about the survey participants is summarized in Table 5.1.

Table 5.1: Summary Statistics Sample

Variable	N	Mean	Std. Dev.	Min	Max
Demographics					
Male	1,174	0.66	0.47	0	1
Age	1,174	58.39	15.47	21	92
Net Household Income	1,174	2,803	1,384	0	12,617
Wealth	1,174	52,116	16,4791	1	2,874,771
Socioeconomic Status	1,173	3.62	1.05	1	5
Educational Degree Dummies					
School degree	1,174	0.36	0.48	0	1
Vocational Degree	1,174	0.48	0.50	0	1
University degree	1,174	0.16	0.37	0	1
Married	1,174	0.60	0.49	0	1
Divorced	1,174	0.07	0.25	0	1
Number of Children in Household	1,174	0.49	0.92	0	5
Self Employed	1,174	0.05	0.22	0	1
Retired	1,174	0.36	0.48	0	1
Unemployed	1,174	0.07	0.26	0	1
Government Employee	1,174	0.09	0.29	0	1
Risk-Propensity Score	1,092	0.00	0.83	-1.22	2.24
Intellectual Virtues					
IVS Score	1,159	0.00	0.64	-3.83	3.53
Love of Knowledge	1,159	3.37	0.65	1	5
Openness	1,159	3.20	0.57	1	5
Conscientiousness	1,158	3.12	0.58	1	5
Humility	1,158	2.91	0.45	1	5
Courage	1,157	2.91	0.51	1	5
Dependent Variables					
Basic Financial Literacy	1,174	4.19	0.90	1	5
Advanced Financial Literacy	1,174	6.57	3.13	0	11
Mortgage Literacy	1,174	3.18	1.78	0	6
Self-assessment Basic Financial Literacy	1,171	-0.24	1.13	-4	4
Self-assessment Advanced Financial Literacy	1,169	-0.47	2.13	-7	11
Self-assessment Mortgage Financial Literacy	1,164	0.16	1.43	-4	6
Advisors Compared?	726	0.23	0.42	0	1

5.3.2 Measuring Intellectual Virtues

In order to elicit the intellectual virtues of the participants in our study, we administer the Intellectual Virtue Scale (IVS). The IVS is a new instrument designed to measure intellectual virtue. The IVS has been validated in previous work (Chapter 4), demonstrating the *internal validity* of the scale. Internal validity is a measure of whether the items in a scale have a high internal consistency and exhibit the expected factor structure (DeVellis 2016).

What has not been shown to date is that the IVS is also *construct-valid*. Construct validity concerns whether the measurement instrument is appropriately related to outcome measures (DeVellis 2016). To show that the IVS is construct valid, we need to demonstrate that higher scores on the scale are associated with better knowledge and understanding. Here we investigate the relationship between the IVS and financial knowledge as well as conscientious and reflective conduct in making financial decisions.

The Intellectual Virtue Scale is to our knowledge the first instrument to measure intellectual virtue in depth. We measure the five intellectual virtues described above with four items each, leading to a twenty-item self-reporting questionnaire.[4]

Figure 5.1 illustrates the summary statistics as boxplots of the individual virtue scores.[5] Note that each item is scored from zero (deficit) to five (excess), with the virtuous value at three. Ideally virtuous individuals would score three for each of the virtues.

Average respondents score close to the virtuous mean, as indicated by the fact that all means fall within one standard deviation of 3. Variance is lowest for humility (SD 0.46), and highest

[4] The wording of the items is contained in Appendix 14. Appendix 2 confirms that the IVS meets psychometric standards concerning its factor structure and internal validity.

[5] Table 5.1 shows the summary statistics for the scores of the individual intellectual virtues, obtained by averaging the values of the four items pertaining to each virtue. Appendix 3 contains a histogram for each virtue.

for love of knowledge (0.65). This result shows that with regard to some virtues, there is more perceived diversity among Dutch households than for others.

There are correlations between the intellectual virtue scores, as shown in Appendix 3. Almost all correlations are positive, with the exception of two small negative correlations between humility and love of knowledge as well as conscientiousness. This result indicates that there are not trade-offs between intellectual virtues in the sense that having some precludes the development of others. Rather, bearers of some virtues are more likely to bear some other virtues as well. Intellectual virtues thus appear to be interdependent and mutually reinforcing. Correlations are strongest between love of knowledge, openness, and conscientiousness, ranging between 0.45 and 0.48. Intellectual courage is correlated with these three virtues as well, but coefficients are smaller, between 0.15 and 0.29. Correlations are weakest between humility and the other virtues, ranging between -0.01 with love of knowledge to 0.28 with conscientiousness. An explanation for the weaker correlation between humility and the other virtues could be that humility requires that people take up a critical perspective on their quest for knowledge. Humility is concerned with interrogating one's assumed knowledge as to whether it really is backed up by sufficient evidence. This self-critical critical perspective may be largely independent of other intellectual virtues.

Among the virtues, respondents report the highest levels of love of knowledge, followed by openness and conscientiousness. The results are qualitatively similar to the results from the validation study (chapter 4). It is notable that respondents tend to report somewhat excessive levels of love of knowledge, conscientiousness, and openness, while reporting somewhat deficient levels of humility and intellectual courage. This pattern was also present in the validation study.

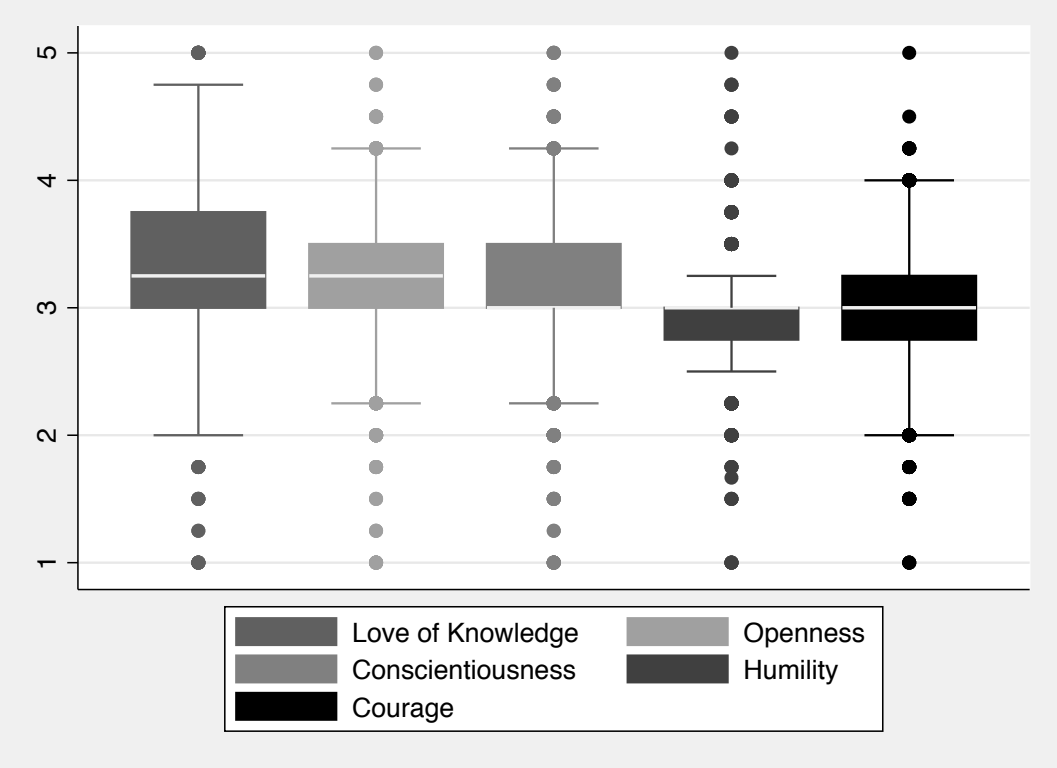

Figure 5.1: Boxplot of intellectual virtue score for individual virtues

In order for all five virtues to have an equal impact on the overall intellectual virtue score, we calculate the intellectual virtue score as the mean of the z-values of the individual virtue scores.

To understand better which demographic factors are associated with higher scores in intellectual virtue, we regress demographic characteristics of the population on the intellectual virtue score (Appendix 17). Educational background is significant at a 1% level. Participants who completed vocational training achieve higher scores than participants who only graduated from secondary school, and participants with a university degree do better than participants with vocational training. This suggests that participants with more formal training tend to display more intellectual virtue.

The other characteristic that is significant at a 1% level is the propensity to take risks. The greater the propensity of participants to take risk, the higher their intellectual virtue score. This result can be explained by the greater need for knowledge of people running risks. Intuitively,

people investing in the stock market have a greater need of and use for knowledge about finance than people who invest in less volatile assets. Similarly, people doing risky sports need to acquire knowledge about safety precautions to keep themselves out of harm's way than people who do not engage in risky sports.

Other variables are significant at a lower level of significance. We find that divorced participants tend to score higher on intellectual virtue, significant at the 5% level. Concerning age, participants in every age bracket above the youngest 18-24 age bracket tend to score slightly lower on intellectual virtue than the participants in this youngest age bracket, significant at a 10% level. Wealth and Socioeconomic Status is positively related to intellectual virtue, with the coefficients significant at the 10% level. Gender does not appear to be correlated with intellectual virtue scores. The overall association of intellectual virtue with demographic variables is small, however, as indicated by an R^2 for the whole regression of 0.07.

5.3.3 Measuring Financial Literacy and Self-Awareness of Financial Knowledge

We elicit financial literacy with two established measures, basic and advanced financial literacy, as well as one novel measure, the Mortgage Literacy Questionnaire. Appendix 14 shows the exact wording of the questions. Summary statistics for the scores associated with each measure are contained in Appendix 3.

The basic and advanced financial literacy questionnaires assess understanding of basic economic principles such as interest rates, inflation, and portfolio diversification, as well as characteristics of financial instruments. These questions or a subset thereof have been used in almost all studies on financial literacy referred to in section 5.2, making the basic and advanced financial literacy questionnaires the established measure of financial literature (Huston 2010).

Our results are very similar to the results reported by van Rooij et al. using the same panel in 2011 (Van Rooij, Lusardi, and Alessie 2011a).

The novel measure we employ is the Mortgage Literacy Questionnaire (MLQ). We have developed the MLQ to assess mortgage-specific knowledge not covered by basic and financial literacy questionnaires, including legal and fiscal aspects of mortgages. In another study, we show that mortgage literacy is associated with mortgage risks and mortgage risk management over and above financial literacy (cf. chapter 3).

To evaluate self-awareness of financial literacy, we ask respondents how many questions they believe they answered correctly for each of the literacy measures. Measuring self-awareness enables us to investigate whether higher levels of intellectual virtue are associated with higher levels of self-awareness about one's financial knowledge or the lack thereof. Detailed results for each of the measures are contained in Appendix 3. In Table 5.16, we report estimates of correct answers by actual literacy scores. We find that mean and median estimates track the actual scores closely. In cases of advanced financial literacy for instance, the median does not deviate by more than one from the actual score. But these measures mask to what extent many respondents make mistakes in estimating the number of correct answers. Between 26% of participants (mortgage literacy) and 44% of participants (basic financial literacy) estimate their scores correctly. The remaining participants are either over- or under-confident. Still, a large part of respondents is at least approximately accurate in their self-assessments.

Respondents are more confident about their knowledge about mortgages than about basic and advanced financial literacy. Only in case of mortgage literacy is the proportion of respondents who overestimate their scores higher than the proportion of respondents who underestimate their scores. Table 5.2 shows the difference between the self-assessment of respondents and their score for basic and advanced financial literacy, as well as for mortgage literacy. If respondents score zero on this measure, their self-assessment is exactly in line with their actual

literacy score. Negative values indicate that respondents are on average under-confident. Positive values indicate that respondents are on average over-confident. Concerning advanced financial literacy, respondents underestimate their score by half a question on average. It is only with respect to mortgage literacy that respondents are overconfident.

Table 5.2: Difference between self-assessment and correct questions

Variable	N	Mean	Std. Dev.	Min	Max
Basic Financial Literacy	1,171	-0.24	1.13	-4	4
Advanced Financial Literacy	1,169	-0.47	2.13	-7	11
Mortgage Debt Literacy	1,164	0.16	1.43	-4	6

5.3.4 Measuring Propensity to Compare Advisors

Financial literacy and self-knowledge about financial literacy are determinants of economic decision making. By contrast, in using the propensity to compare advisors as an outcome variable, we attempt to demonstrate a *direct* association between intellectual virtue and economic decision making. By contrast, our final outcome variable concerns economic decision making directly. We assess whether participants compare financial advisors before settling for one.

Financial advisors differ in price as well as quality (De Bruin 2014, chs. 3-4). In the Netherlands, price differences between financial advisors amount to several hundred Euros per mortgage. But whether financial advisors select a suitable mortgage at a low interest rate is even more crucial. Small differences between mortgage rates can easily increase interest payments over the lifetime of a mortgage by several thousands of Euros. Hence taking care in selecting a financial advisor matters considerably for household finances. We expect that intellectually virtuous people are more likely to display the intellectual courage required to resist working with the first advisor one encounters, and to display the conscientiousness to compare several advisors.

The overwhelming majority of respondents works with financial advisors, regardless of their level of financial literacy. Of the 872 respondents who have taken out a mortgage, 83% have worked with a financial advisor (N=726). Yet more than three quarters of participants who worked with a financial advisor report that they did not compare advisors. As Table 5.3 shows, most respondents who compared advisors sought some kind of direct contact with them, either in person, or via phone or email (15%). Smaller groups compared offerings of financial advisors online (5%) or took guidance from family or friends (7%).

Table 5.3: How respondents compared different financial advisors

	N	Percent
Compared different advisors in person, on phone, or via email contact	107	15%
Compared different advisors online	33	5%
Took guidance from family or friends about different advisors	48	7%
Has not compared advisors	556	76%
Total	744	103%

Note: Among the first three answer options, selecting multiple options was possible.

What are the reasons not to compare advisors? Table 5.4 lists responses from our survey. The majority of respondents say that they trusted the advisor they selected (58%). Since these respondents did not compare different financial advisors, it is unlikely that they had much evidence of the comparative quality of their particular advisor. It appears that many respondents trusted their advisor in the absence of any evidence of their quality. There is only a small share of respondents who indicate that comparing advisors was difficult. This result suggests that for most respondents, the reason for not comparing advisors is not lack of cognitive ability or access to information, but lack of diligence.

Table 5.4: Why people did not compare advisors

	N	Percent
I trust the advisor I selected	321	58%
Comparison was difficult	11	2%
First advisor I came across was good enough	97	17%
Other	79	14%
I don't know	48	9%
Total	556	100%

5.4 Results

5.4.1 Intellectual virtue and financial literacy

We expect that the IVS is positively associated with financial literacy scores. To test this hypothesis, we run an OLS regression with standardized scores of basic, advanced, and mortgage literacy as dependent variables, respectively. We use the following controls throughout: log household income, log household wealth, socioeconomic status, gender, education, age, marriage status, number of children, employment status, risk propensity.

Table 5.5 shows the regression results. Columns 1-3 use the summary measure of intellectual virtue as independent variable, testing one of the three kinds of financial literacy we discussed in section 5.3.3: basic financial literacy, advanced financial literacy, and mortgage literacy. The association of advanced financial literacy and mortgage literacy with intellectual virtue is significant at the 1% level, and of basic financial literacy with intellectual virtue at a 10% level.

Note that we are using standardised scores, both for the IVS scores and the financial literacy scores throughout. Hence the coefficients can be interpreted in terms of fractions of standard deviations. For instance, the coefficient of the IVS score in column 1 means that an increase in one standard deviation in intellectual virtue is associated with an increase in basic financial literacy of 5% of a standard deviation. The associations of intellectual virtue with mortgage literacy and advanced financial literacy are even stronger. An increase in intellectual virtue of

one standard deviation is associated with an increase in mortgage literacy of 0.08 standard deviations, and with an increase in advanced financial literacy of 0.12 standard deviations.

Intellectual virtue is most strongly associated with advanced financial literacy. Moreover, Van Rooij finds that advanced financial literacy is most strongly associated with economic behaviour of households. We therefore investigate this measure of financial literacy in detail in columns 4-9. In columns 4-8, we use one of the five intellectual virtues as dependent variable, respectively. Column 9 includes all five intellectual virtues as dependent variables jointly. The regressions show that the positive association between intellectual virtue and advanced financial literacy is driven by three virtues: love of knowledge and openness, which are significant at a 1% level individually, and conscientiousness, which is significant at the 5% level. Love of knowledge remains significant at the 1% level in column 9 as well. Humility and courage are not significantly associated with advanced financial literacy in individual regressions.

The results for individual virtues make sense given the meaning of the virtues. Acquiring financial knowledge requires motivation to learn, which is captured by love of knowledge; openness to different perspectives, as captured by openness in information gathering; and careful processing of information, as captured by conscientiousness in information processing. By contrast, humility does not seem to be essential to master financial concepts. Being boastful does not seem to be a hindrance to becoming financially literate. Nor is a special amount of intellectual courage required to acquire basic financial knowledge, as the information can be obtained from many sources, including magazines and the internet, that do not require courage.

We thus find support for our expectation that intellectual virtue is positively associated with financial literacy. Our regression approach does not establish causation, nor indicate the direction of causation. But the result is consistent with our expectation that intellectual virtue supports gaining financial knowledge.

Table 5.5: Regression results: Intellectual virtue and financial literacy

	(1) BFL	(2) AFL	(3) ML	(4) AFL	(5) AFL	(6) AFL	(7) AFL	(8) AFL	(9) AFL
IVS Score	0.0522*	0.1162***	0.0758***						
	(0.0306)	(0.0264)	(0.0285)						
Love of Knowledge				0.1832***					0.1751***
				(0.0267)					(0.0320)
Openness					0.1044***				0.0484
					(0.0256)				(0.0301)
Conscientiousness						0.0643**			-0.0145
						(0.0259)			(0.0300)
Humility							-0.0099		-0.0180
							(0.0261)		(0.0273)
Courage								0.0228	-0.0319
								(0.0257)	(0.0264)
Male	0.1907***	0.4227***	0.1736***	0.3982***	0.4328***	0.4252***	0.4147***	0.4088***	0.4108***
	(0.0689)	(0.0595)	(0.0642)	(0.0588)	(0.0597)	(0.0599)	(0.0607)	(0.0607)	(0.0603)
Log Net Household Income	0.0530	0.2039***	0.2422***	0.1869***	0.1978***	0.1988***	0.1988***	0.2025***	0.1771***
	(0.0739)	(0.0638)	(0.0688)	(0.0631)	(0.0639)	(0.0642)	(0.0645)	(0.0645)	(0.0633)
Log Wealth	0.0382***	0.0718***	0.0512***	0.0682***	0.0727***	0.0705***	0.0724***	0.0728***	0.0665***
	(0.0111)	(0.0096)	(0.0104)	(0.0095)	(0.0096)	(0.0097)	(0.0097)	(0.0097)	(0.0096)
Socio-Economic Status	0.0848**	0.1258***	0.1818***	0.1143***	0.1354***	0.1364***	0.1391***	0.1375***	0.1229***
	(0.0385)	(0.0332)	(0.0358)	(0.0329)	(0.0332)	(0.0334)	(0.0335)	(0.0335)	(0.0330)
Married	0.0293	0.0066	0.1809***	0.0075	0.0196	0.0142	0.0237	0.0204	0.0147
	(0.0740)	(0.0639)	(0.0689)	(0.0631)	(0.0639)	(0.0643)	(0.0644)	(0.0644)	(0.0632)
Divorced	0.0840	0.0892	0.2442**	0.0722	0.0952	0.1054	0.1142	0.1092	0.0664
	(0.1279)	(0.1104)	(0.1190)	(0.1090)	(0.1105)	(0.1109)	(0.1111)	(0.1113)	(0.1091)
Number of Children	0.0213	-0.0083	0.0227	-0.0070	-0.0107	-0.0064	-0.0089	-0.0092	-0.0033
	(0.0397)	(0.0343)	(0.0370)	(0.0339)	(0.0343)	(0.0346)	(0.0347)	(0.0347)	(0.0340)
Self-Employed	-0.1416	0.0375	0.1141	0.0556	0.0552	0.0358	0.0400	0.0347	0.0658
	(0.1365)	(0.1178)	(0.1271)	(0.1163)	(0.1180)	(0.1185)	(0.1189)	(0.1188)	(0.1165)
Retired	0.0953	-0.0145	0.0972	0.0031	-0.0135	-0.0075	-0.0042	-0.0064	0.0054
	(0.1140)	(0.0984)	(0.1061)	(0.0972)	(0.0986)	(0.0989)	(0.0993)	(0.0992)	(0.0972)
Unemployed	0.0212	0.0468	-0.1542	0.0595	0.0516	0.0486	0.0501	0.0528	0.0842
	(0.1247)	(0.1077)	(0.1161)	(0.1063)	(0.1079)	(0.1087)	(0.1090)	(0.1091)	(0.1069)
Government Worker	0.2153**	0.1302	0.0896	0.1164	0.1287	0.1215	0.1107	0.1084	0.1197
	(0.1055)	(0.0911)	(0.0983)	(0.0899)	(0.0912)	(0.0916)	(0.0923)	(0.0920)	(0.0906)
Risk-Proneness	0.1226***	0.2477***	0.1355***	0.2428***	0.2483***	0.2533***	0.2603***	0.2606***	0.2389***
	(0.0374)	(0.0323)	(0.0348)	(0.0318)	(0.0323)	(0.0324)	(0.0324)	(0.0324)	(0.0319)
Age (18-24 omitted)									
25-34 years	-0.1072	0.1560	0.2273	-0.0117	0.0351	0.1527	-0.0048	0.0123	-0.0577
	(0.6763)	(0.5839)	(0.6296)	(0.5756)	(0.5838)	(0.5887)	(0.5901)	(0.5879)	(0.5798)
35-44 years	-0.0880	0.0718	0.1825	-0.0714	-0.0616	0.0659	-0.0985	-0.0880	-0.1308
	(0.6763)	(0.5840)	(0.6297)	(0.5756)	(0.5838)	(0.5890)	(0.5900)	(0.5878)	(0.5800)
45-54 years	-0.0070	0.1554	0.1405	0.0313	0.0203	0.1636	0.0035	0.0119	-0.0210
	(0.6758)	(0.5835)	(0.6292)	(0.5753)	(0.5835)	(0.5885)	(0.5894)	(0.5875)	(0.5795)
55-64 years	-0.0925	0.2031	0.2268	0.0929	0.0614	0.2050	0.0396	0.0472	0.0343
	(0.6744)	(0.5823)	(0.6279)	(0.5740)	(0.5822)	(0.5874)	(0.5882)	(0.5862)	(0.5785)
older than 65 years	-0.1290	0.2163	0.0649	0.1079	0.0791	0.2146	0.0478	0.0553	0.0554
	(0.6785)	(0.5858)	(0.6317)	(0.5774)	(0.5856)	(0.5909)	(0.5917)	(0.5897)	(0.5818)
Education (School Degree omitted)									
Vocational Degree	0.0872	-0.0400	-0.0495	-0.0435	-0.0367	-0.0211	-0.0091	-0.0117	-0.0461
	(0.0741)	(0.0639)	(0.0689)	(0.0630)	(0.0640)	(0.0641)	(0.0642)	(0.0641)	(0.0631)
University Degree	0.2680**	0.0986	0.0232	0.0623	0.0957	0.1208	0.1357	0.1325	0.0463
	(0.1182)	(0.1021)	(0.1101)	(0.1010)	(0.1024)	(0.1024)	(0.1025)	(0.1026)	(0.1012)
Constant	-1.2477	-3.1229***	-3.3804***	-2.7794***	-2.9980***	-3.1308***	-2.9995***	-3.0252***	-2.6761***
	(0.8374)	(0.7231)	(0.7797)	(0.7150)	(0.7241)	(0.7283)	(0.7330)	(0.7296)	(0.7205)
Observations	1,062	1,062	1,062	1,062	1,062	1,061	1,061	1,060	1,060
R-squared	0.1086	0.2984	0.2061	0.3163	0.2966	0.2883	0.2842	0.2847	0.3175
Adjusted R-squared	0.0915	0.285	0.191	0.303	0.283	0.275	0.270	0.271	0.302

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5.4.2 Intellectual virtue and self-awareness about financial knowledge

We expect that intellectual virtue is positively correlated with the accuracy of self-awareness about financial literacy. To test the hypothesis, we run an OLS regression with self-awareness scores for basic, advanced, and mortgage literacy scores as dependent variables.

Table 5.6 shows the results. Recall that we compute self-awareness as the difference between the actual number of correctly answered literacy questions and the participant's estimation of the number of correctly answered questions, as explained in section 5.3.3. On average, respondents are roughly realistic in their self-assessment. Negative coefficients are therefore a

sign of a self-critical attitude towards one own knowledge, and positive coefficients a sign of an optimistic attitude towards one's self-knowledge.

In columns 1-3, we test the association of intellectual virtue with self-awareness of knowledge about basic, advanced, and mortgage literacy, respectively. The dependent variable is the z-score of the intellectual virtue score. The intellectual virtue score is not significantly associated with any of the literacy scores. At first sight, it might appear that intellectual virtue does not matter for self-awareness about financial knowledge.

But once we investigate intellectual virtues separately, it turns out that the aggregate measure of intellectual virtue masks significant relationships between individual virtues and self-knowledge about advanced financial literacy, which we investigate in columns 4-9. Columns 4-8 use one of the five individual virtues as independent variables, respectively. Column 9 includes all five virtues jointly as independent variables. While humility and courage are both significantly related to self-knowledge, their coefficient have opposite signs. Participants who score higher on humility tend to have a more self-critical attitude towards their knowledge about finance. By contrast, participants who score higher on courage tend to have a more optimistic attitude towards their knowledge about finance. When these scores are combined in aggregate intellectual virtue measure, they cancel each other out.

We thus find support for the expectation that intellectual virtue is associated with self-knowledge about finance, if not on the aggregate level. The association of humility with a self-critical attitude towards one's knowledge is in line with expectations. What is more surprising is that intellectual courage seems to be associated with lower levels of self-knowledge. This result suggests that intellectual courage, including the courage to question claims of others, is grounded in a high level of reassurance concerning one's own knowledge.

Table 5.6: Regression Results: Intellectual virtue and self-awareness concerning financial knowledge

Variables	(1) BFL	(2) AFL	(3) ML	(4) AFL	(5) AFL	(6) AFL	(7) AFL	(8) AFL	(9) AFL
IVS Score	0.0370	0.0087	0.0580						
	(0.0341)	(0.0662)	(0.0451)						
Love of Knowledge				0.0422					-0.0294
				(0.0678)					(0.0810)
Openness					0.0082				0.0067
					(0.0640)				(0.0761)
Conscientiousness						0.0154			0.0608
						(0.0645)			(0.0759)
Humility							-0.1835***		-0.2046***
							(0.0646)		(0.0691)
Courage								0.1443**	0.1432**
								(0.0638)	(0.0667)
Male	0.3443***	0.5150***	0.5965***	0.5104***	0.5158***	0.5151***	0.4478***	0.4632***	0.3995***
	(0.0768)	(0.1492)	(0.1016)	(0.1492)	(0.1495)	(0.1494)	(0.1504)	(0.1506)	(0.1526)
Log Net Household Income	0.0298	-0.2224	-0.0263	-0.2267	-0.2229	-0.2198	-0.2424	-0.2152	-0.2378
	(0.0824)	(0.1599)	(0.1089)	(0.1601)	(0.1600)	(0.1602)	(0.1598)	(0.1600)	(0.1601)
Log Wealth	0.0075	-0.0652***	0.0093	-0.0664***	-0.0652***	-0.0648***	-0.0656***	-0.0630***	-0.0652***
	(0.0124)	(0.0241)	(0.0164)	(0.0241)	(0.0241)	(0.0242)	(0.0241)	(0.0241)	(0.0242)
Socio-Economic Status	0.0620	-0.0303	-0.1155**	-0.0343	-0.0295	-0.0321	-0.0220	-0.0395	-0.0273
	(0.0429)	(0.0832)	(0.0567)	(0.0834)	(0.0831)	(0.0833)	(0.0831)	(0.0832)	(0.0836)
Married	0.1402*	-0.0657	-0.1392	-0.0677	-0.0647	-0.0675	-0.0451	-0.0748	-0.0586
	(0.0825)	(0.1602)	(0.1091)	(0.1601)	(0.1600)	(0.1603)	(0.1597)	(0.1599)	(0.1598)
Divorced	0.0450	-0.3810	-0.1622	-0.3897	-0.3807	-0.3784	-0.3809	-0.4083	-0.4159
	(0.1425)	(0.2767)	(0.1884)	(0.2767)	(0.2766)	(0.2765)	(0.2753)	(0.2762)	(0.2760)
Number of Children	-0.0115	0.0247	-0.0167	0.0257	0.0245	0.0225	0.0127	0.0205	0.0104
	(0.0443)	(0.0860)	(0.0586)	(0.0860)	(0.0859)	(0.0862)	(0.0859)	(0.0861)	(0.0860)
Self-Employed	0.2085	0.0222	-0.2428	0.0259	0.0236	0.0227	0.0516	0.0076	0.0341
	(0.1521)	(0.2953)	(0.2011)	(0.2953)	(0.2955)	(0.2955)	(0.2945)	(0.2950)	(0.2948)
Retired	0.0451	-0.1326	-0.1389	-0.1295	-0.1325	-0.1337	-0.1045	-0.1340	-0.1061
	(0.1271)	(0.2467)	(0.1680)	(0.2466)	(0.2467)	(0.2468)	(0.2460)	(0.2463)	(0.2460)
Unemployed	-0.0835	-0.2023	0.0320	-0.1967	-0.2019	-0.2134	-0.2048	-0.1933	-0.1883
	(0.1390)	(0.2698)	(0.1838)	(0.2698)	(0.2700)	(0.2712)	(0.2701)	(0.2708)	(0.2706)
Government Worker	-0.2086*	0.0809	-0.0941	0.0801	0.0809	0.0816	0.0099	0.0495	-0.0224
	(0.1176)	(0.2284)	(0.1555)	(0.2282)	(0.2284)	(0.2284)	(0.2288)	(0.2283)	(0.2292)
Risk-Proneness	0.0150	-0.0405	0.0305	-0.0437	-0.0405	-0.0404	-0.0297	-0.0376	-0.0309
	(0.0416)	(0.0809)	(0.0551)	(0.0808)	(0.0809)	(0.0808)	(0.0803)	(0.0804)	(0.0808)
Age (18-24 omitted)									
25-34 years	-0.6301	-0.3073	-0.0992	-0.3246	-0.3163	-0.2829	-0.6783	-0.3631	-0.6258
	(0.7538)	(1.4635)	(0.9966)	(1.4612)	(1.4614)	(1.4685)	(1.4619)	(1.4594)	(1.4672)
35-44 years	-0.6063	0.4347	0.3573	0.4241	0.4248	0.4622	0.0684	0.3753	0.1123
	(0.7538)	(1.4636)	(0.9967)	(1.4610)	(1.4613)	(1.4691)	(1.4618)	(1.4592)	(1.4677)
45-54 years	-0.5388	0.5770	0.2603	0.5694	0.5669	0.6002	0.2274	0.5077	0.2619
	(0.7532)	(1.4625)	(0.9959)	(1.4602)	(1.4605)	(1.4680)	(1.4603)	(1.4584)	(1.4664)
55-64 years	-0.5068	0.4402	0.2713	0.4369	0.4296	0.4665	0.0882	0.3687	0.1194
	(0.7517)	(1.4595)	(0.9939)	(1.4571)	(1.4573)	(1.4653)	(1.4573)	(1.4553)	(1.4638)
older than 65 years	-0.5054	0.7991	0.5061	0.7971	0.7889	0.8245	0.4394	0.7217	0.4659
	(0.7562)	(1.4683)	(0.9999)	(1.4657)	(1.4659)	(1.4740)	(1.4660)	(1.4639)	(1.4723)
Education (School Degree omitted)									
Vocational Degree	-0.0733	0.0612	0.0820	0.0558	0.0614	0.0606	0.0874	0.0524	0.0733
	(0.0825)	(0.1603)	(0.1091)	(0.1598)	(0.1602)	(0.1598)	(0.1591)	(0.1592)	(0.1598)
University Degree	-0.0530	0.2973	0.0186	0.2826	0.2969	0.2981	0.2937	0.2903	0.2747
	(0.1318)	(0.2559)	(0.1743)	(0.2564)	(0.2562)	(0.2554)	(0.2540)	(0.2546)	(0.2561)
Constant	-0.4656	1.0591	0.0721	1.1301	1.0687	1.0180	1.5654	1.1401	1.5709
	(0.9334)	(1.8122)	(1.2341)	(1.8148)	(1.8125)	(1.8166)	(1.8160)	(1.8111)	(1.8231)
Observations	1,062	1,062	1,062	1,062	1,062	1,061	1,061	1,060	1,060
R-squared	0.0580	0.0428	0.0636	0.0431	0.0428	0.0424	0.0497	0.0466	0.0548
Adjusted R-squared	0.0399	0.0244	0.0456	0.0247	0.0244	0.0240	0.0315	0.0283	0.0329

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

5.4.3 Intellectual Virtue and Propensity to Compare Advisors

We now turn to the relationship between intellectual virtue and conscientiousness in financial decision making. Based on the discussion in section 5.3.4, we expect that intellectually virtuous people are more likely to compare financial advisors. The main reason is that advisors differ in price and quality. Selecting a good advisor can make a major difference to household finances. We expect intellectually virtuous people to be more likely to realise the potential gains of comparing advisors, be motivated to act on this insight, and display the intellectual courage to

resist working with the first advisor they encounter. We use the dummy variable measuring whether people compared advisors as dependent variable in a probit analysis, with the standardized intellectual virtue scores and individual virtue scores as independent variables, as well as standard controls. Table 5.7 shows the regression results.

Column 1 includes the standardized intellectual virtue score as independent variable. The relationship between intellectual virtue and advisor comparison is positive, significant at a 1% level, and fairly large. An increase in intellectual virtue by one standard deviation is associated with an increase in the likelihood to compare advisors of 27%.

Columns 2-6 include one of the individual virtues as independent variables, respectively. Except for humility, individually all virtues are positively associated with advice-seeking at a 1% level. Column 7 includes all five virtues jointly as independent variables. Intellectual courage and humility both remain significant at the 10% level. Love of knowledge and openness are no longer significant, due to collinearity. In sum, we find support for our expectation that intellectual virtue is associated with a greater likelihood that people compare financial advisors before making their choice.

Is it exclusively intellectual virtue that is positively related with the tendency to compare financial advisors, or is financial literacy also correlated with whether people compare financial advisors? We show in Appendix 18 that none of the three financial literacy measures is significantly positively associated with the tendency to compare advisors. In fact, people who score higher on basic financial literacy are significantly less likely to compare financial advisors. Hence intellectual virtue is associated with this example of conscientious financial decision making in a way that financial literacy is not.

Table 5.7: Regression Results: Intellectual virtues and whether people compare advisors

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
IVS Score	0.2686***						
	(0.0664)						
Love of Knowledge		0.1906***					0.0842
		(0.0619)					(0.0705)
Openness			0.1907***				0.0995
			(0.0633)				(0.0720)
Conscientiousness				0.1907***			0.1308*
				(0.0605)			(0.0688)
Humility					0.0040		-0.0403
					(0.0598)		(0.0650)
Courage						0.1451***	0.1057*
						(0.0557)	(0.0576)
Male	0.1918	0.1792	0.2077	0.2025	0.1874	0.1192	0.1399
	(0.1319)	(0.1318)	(0.1312)	(0.1314)	(0.1320)	(0.1330)	(0.1367)
Log Net Household Income	0.0416	0.0151	0.0433	0.0247	0.0323	0.0538	0.0421
	(0.1589)	(0.1567)	(0.1579)	(0.1585)	(0.1570)	(0.1584)	(0.1598)
Log Wealth	-0.0558**	-0.0532**	-0.0523**	-0.0536**	-0.0469**	-0.0483**	-0.0573**
	(0.0230)	(0.0228)	(0.0229)	(0.0229)	(0.0226)	(0.0227)	(0.0231)
Socio-Economic Status	0.0169	0.0170	0.0406	0.0296	0.0435	0.0396	0.0197
	(0.0797)	(0.0796)	(0.0790)	(0.0791)	(0.0785)	(0.0787)	(0.0804)
Married	-0.3406**	-0.3301**	-0.3299**	-0.3368**	-0.3241**	-0.3332**	-0.3487**
	(0.1407)	(0.1399)	(0.1400)	(0.1403)	(0.1391)	(0.1397)	(0.1413)
Divorced	-0.5210**	-0.5045**	-0.5081**	-0.4807*	-0.4508*	-0.4798*	-0.5488**
	(0.2571)	(0.2564)	(0.2559)	(0.2567)	(0.2529)	(0.2541)	(0.2602)
Number of Children	0.0023	0.0015	0.0011	0.0091	0.0071	0.0033	-0.0005
	(0.0662)	(0.0660)	(0.0657)	(0.0659)	(0.0654)	(0.0658)	(0.0666)
Self-Employed	-0.3566	-0.2964	-0.3284	-0.3096	-0.3196	-0.3699	-0.3346
	(0.2724)	(0.2641)	(0.2676)	(0.2656)	(0.2624)	(0.2707)	(0.2753)
Retired	-0.0676	-0.0613	-0.0512	-0.0788	-0.0889	-0.1033	-0.0582
	(0.2444)	(0.2418)	(0.2418)	(0.2424)	(0.2418)	(0.2435)	(0.2433)
Unemployed	-0.0335	-0.0323	0.0368	-0.0708	-0.0399	-0.0333	-0.0053
	(0.2922)	(0.2928)	(0.2925)	(0.2892)	(0.2898)	(0.2890)	(0.2934)
Government Worker	0.1672	0.1478	0.1579	0.1553	0.1543	0.1169	0.1114
	(0.1776)	(0.1768)	(0.1770)	(0.1764)	(0.1769)	(0.1766)	(0.1801)
Risk-Proneness	0.0345	0.0367	0.0374	0.0426	0.0510	0.0586	0.0406
	(0.0718)	(0.0715)	(0.0716)	(0.0714)	(0.0709)	(0.0711)	(0.0724)
Age (18-34 omitted)							
35-44 years	0.0208	0.0706	0.0176	0.0342	0.0440	0.0189	0.0222
	(0.2258)	(0.2260)	(0.2257)	(0.2264)	(0.2250)	(0.2262)	(0.2288)
45-54 years	-0.1786	-0.0737	-0.1569	-0.1270	-0.0922	-0.1444	-0.1698
	(0.2267)	(0.2263)	(0.2265)	(0.2259)	(0.2256)	(0.2268)	(0.2304)
55-64 years	-0.1551	-0.0406	-0.1440	-0.1015	-0.0780	-0.1208	-0.1329
	(0.2320)	(0.2315)	(0.2319)	(0.2313)	(0.2315)	(0.2318)	(0.2362)
older than 65 years	-0.3283	-0.2067	-0.3374	-0.2502	-0.2294	-0.2605	-0.3016
	(0.3048)	(0.3024)	(0.3044)	(0.3029)	(0.3034)	(0.3042)	(0.3074)
Education (School Degree omitted)							
Vocational Degree	-0.1086	-0.0988	-0.1117	-0.0975	-0.0882	-0.0963	-0.1186
	(0.1471)	(0.1466)	(0.1463)	(0.1464)	(0.1455)	(0.1458)	(0.1474)
University Degree	0.0199	0.0062	0.0021	0.0420	0.0572	0.0466	-0.0214
	(0.2250)	(0.2248)	(0.2244)	(0.2238)	(0.2224)	(0.2225)	(0.2272)
Constant	-0.2425	-0.1510	-0.3923	-0.2362	-0.4178	-0.4598	-0.2115
	(1.2187)	(1.2036)	(1.2133)	(1.2185)	(1.2079)	(1.2167)	(1.2245)
Observations	677	677	677	677	677	676	676
Pseudo R-squared	0.0587	0.0491	0.0487	0.0497	0.0362	0.0456	0.0643

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5.5 Discussion and Conclusion

Our research question is whether intellectual virtue is associated with greater financial literacy and with a more reflective and conscientious approach to financial decision making. We approached this question by analysing whether intellectual virtue is associated with three different measures of financial literacy; with a more accurate estimation of the number of financial literacy questions answered correctly; and with a tendency to compare different financial advisors. We find significant associations between intellectual virtue and each of these three outcome measures.

Taken together, our results suggest that fostering intellectual virtue may provide a way of equipping people to develop financial literacy, deal more courageously with financial advisors, and ultimately make better financial decisions.

Our regression approach does not exclude the possibility that intellectual virtue arises endogenously with financial literacy or financial advisor selection. If intellectual virtue is correlated with unobserved variables, this could lead to falsely attributing the effects of these unobserved variables to intellectual virtue. For instance, education may improve intellectual virtues and foster financial literacy. We addressed this problem by including a large number of controls that may plausibly be related to intellectual virtue, covering education, variables related to wealth and income, socio-economic status, employment status, marriage status, risk aversion, age, and gender.

Another potential source of endogeneity is reverse causality. We assume that intellectual virtue has an effect on financial literacy, self-knowledge, and advisor choice. Causality would be reversed if intellectual virtue would arise from these outcomes, rather than vice versa.

It is however implausible that reverse causality influences our results. Intellectual virtues are relatively stable character traits. While these traits are acquired and improved over time, it is hard to see how our outcome variables would be connected to improved intellectual virtue. Concerning our first regression, reverse causality would implausibly imply that having financial knowledge improves intellectual virtue. Concerning the second regression, reverse causality would be at play if being accurate in one's self-assessment about financial knowledge would improve intellectual virtue, which is also hardly probable. Reverse causality is most plausible concerning the third regression: it is possible that the activity of comparing financial advisors somewhat nourishes intellectual virtue. In particular, the experience of resisting working with the first financial advisor one encounters and instead comparing different advisors may foster intellectual courage. However, intellectual virtues are general character

traits that may be somewhat influenced in every conscious effort we make to acquire knowledge and understanding. The potential impact of comparing advisors on intellectual virtue is therefore small, making it unlikely that it drives the significant results we see in the regression analysis.

This is the first study that investigated the construct validity of the Intellectual Virtue Scale by investigating its relationships with outcomes variables. The expected relationships between the virtues and the studied outcomes hold up well for all five virtues.

The focus of this study was to analyse the relationship between intellectual virtue and financial literacy as well as self-awareness of one's financial knowledge. We thereby contribute to the little explored question of the individual characteristics that determine financial literacy. It is worth noting, however, that the Intellectual Virtue Scale can also be used to investigate the relationship between intellectual virtue and economic decisions directly. Here we have considered but one example of economic decision making, namely the selection process of financial advisors. Future research could widen the range of outcome variables to areas such as pension planning (Alessie, Rooij, and Lusardi 2011) and stock market participation (Van Rooij, Lusardi, and Alessie 2011b).

Appendix 14 Questions Intellectual Virtue Scale and Financial Literacy

	Deficit	Virtue	Excess
Love of Knowledge or curiosity is the disposition to actively and purposefully seek knowledge and understanding.			
L1	I am not very interested in understanding things.	I want to understand things.	I am excessively interested in understanding things.
L2	I am not so interested in the reasons why.	I want to know the reasons why.	I am excessively interested in understanding the reasons why.
L3	I am not particularly curious to learn new things.	I am curious to learn new things.	I get lost in learning new things.
L4	I do not much enjoy gaining knowledge.	I enjoy gaining knowledge.	I unduly enjoy gaining knowledge.
Open-mindedness in gathering information is the disposition to take up different standpoints and perspectives in seeking out evidence and being impartial in appraising the reliability of sources of information.			
O1	I usually get one or at best a few different perspectives on any given topic.	I get a number of different perspectives on a given topic.	I often get more different perspectives on a topic than I can handle.
O2	I pay less attention to the views of people I disagree with.	I consider the views of people I disagree with.	I consider the views of people I disagree with extensively even when their views have little merit.
O3	Loyalty to one's ideas is more important than open-mindedness towards different perspectives.	Open-mindedness towards different perspectives is crucial to overcoming prejudices.	Open-mindedness towards different perspectives is more important than getting to the truth efficiently.
O4	I am not very open-minded towards viewpoints different from my own.	I am open-minded towards viewpoints different from my own.	I am excessively open-minded towards viewpoints different from my own.

Conscientiousness in evaluating information is the disposition to evaluate evidence methodically, thoroughly, and carefully.

C1	I tend not to think things through at great length.	I think things through.	I sometimes mull over things until it is too late.
C2	I make up my mind without much fuss about the many factors that may affect an issue.	I think through the relevant factors before making up my mind.	I think through so many factors that might affect an issue that I sometimes struggle to make up my mind.
C3	I do not dwell on the pros and the cons when I make up my mind.	I weigh the pros and the cons when I make up my mind.	I often get stuck weighing the pros and cons when I make up my mind.
C4	I tend to take important decisions on the spot.	I reason carefully and critically before taking important decisions.	I cannot take important decisions unless I am 100% sure.

Humility in belief formation is the disposition to acknowledge you may be wrong, and to proportion the strength of your beliefs to the strength of your evidence.

H1	I know I am right about most things.	I could be wrong about many things.	I suspect I am wrong about most things.
H2	I tend to be overconfident in my opinions.	I have a realistic sense of what I know.	I lack confidence in what I know.
H3	I have strong opinions about issues I know little about.	The more I know about an issue, the more confident I become of my opinions.	I often lack confidence in my opinions even on issues I know a lot about.
H4	I hold my beliefs firmly even in areas I know little about.	I proportion the strength of my beliefs to the strength of my evidence.	I hardly have any strong beliefs even in areas I know a lot about.

Intellectual Courage is the disposition to pursue knowledge and understanding even if this may negatively affect your wellbeing.

I1	I am afraid to hold an unpopular opinion.	I am not afraid to adopt an unpopular opinion.	I enjoy holding unpopular opinions for the sake of it.
I2	I am afraid to ask questions that could make me look stupid.	I am not afraid to ask questions that could make me look stupid.	I often ask questions that could make me look stupid for the fun of it.
I3	I tend to accept answers I do not understand in order not to appear stupid.	If I do not understand an answer, I keep asking until I understand.	I tend to keep on asking questions for the sake of it.

I4	I avoid asking questions that might reveal my ignorance.	I ask questions even if they reveal my ignorance.	I do not mind at all about how the questions I ask come across.

Table 5.8: Basic Financial Literacy Questions

#	Question	Answer
B1	Numeracy: Suppose you had €100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?	*(i) More than €102;* (ii) Exactly €102; (iii) Less than €102; (iv) Do not know.
B2	Interest compounding: Suppose you had €100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?	*(i) More than €200;* (ii) Exactly €200; (iii) Less than €200; (iv) Do not know.
B3	Inflation: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?	(i) More than today; (ii) Exactly the same; *(iii) Less than today;* (iv) Do not know.
B4	Time value of money: Assume a friend inherits €10,000 today and his sibling inherits €10,000 3 years from now. Who is richer because of the inheritance?	*(i) My friend;* (ii) His sibling; (iii) They are equally rich; (iv) Do not know.
B5	Money illusion: Suppose that in the year 2010, your income has doubled and prices of all goods have doubled too. In 2010, how much will you be able to buy with your income?	(i) More than today; *(ii) The same;* (iii) Less than today; (iv) Do not know.

Table 5.9: Advanced Financial Literacy Questions

#	Question	Answer
A1	Which of the following statements describes the main function of the stock market?	(i) The stock market helps to predict stock earnings; (ii) The stock market results in an increase in the price of stocks***;*** *(iii) The stock market brings people who want to buy stocks together with those who want to sell stocks;* (iv) None of the above; (v) Do not know.
A2	Which of the following statements is correct? If somebody buys the stock of firm B in the stock market:	*(i) He owns a part of firm B;* (ii) He has lent money to firm B; (iii) He is liable for firm B's debts; (iv) None of the above; (v) Do not know.
A3	Which of the following statements is correct?	(i) Once one invests in a mutual fund, one cannot withdraw the money in the first year; *(ii) Mutual funds can invest in several assets, for example invest in both stocks and bonds;* (iii) Mutual funds pay a guaranteed rate of return which depends on their past performance; (iv) None of the above; (v) Do not know.
A4	Which of the following statements is correct? If somebody buys a bond of firm B	(i) He owns a part of firm B*; (ii) He has lent money to firm B;* (iii) He is liable for firm B's debts; (iv) None of the above; (v) Do not know.
A5	Considering a long time period (for example 10 or 20 years), which asset normally gives the highest return?	(i) Savings accounts; (ii) Bonds; *(iii) Stocks*; (iv) Do not know.
A6	Normally, which asset displays the highest fluctuations over time?	(i) Savings accounts; (ii) Bonds; *(iii) Stocks;* (iv) Do not know.
A7	When an investor spreads his money among different assets, does the risk of losing money	(i) Increase; *(ii) Decrease*; (iii) Stay the same; (iv) Do not know.
A8	If you buy a 10-year bond, it means you cannot sell it after 5 years without incurring a major penalty. True or false?	(i) True; *(ii) False*; (iii) Do not know.
A9	Stocks are normally riskier than bonds. True or false?	*(i) True*; (ii) False; (iii) Do not know.
A10	Buying a company stock usually provides a safer return than a stock mutual fund. True or false?	(i) True; *(ii) False*; (iii) Do not know.
A11	If the interest rate falls, what should happen to bond prices?	*(i) Rise*; (ii) Fall; (iii) Stay the same; (iv) None of the above; (v) Do not know; (vi) Refusal.

Table 5.10: Mortgage Literacy Questions

#	Question	Answer
M1	What is the advantage of fixing the interest rate of your mortgage for longer? (select all that apply)	*i) You will not run the risk that interest rates go up unexpectedly.* ii) A longer fixing period is cheaper over the duration. iii) The interest rate is lower in a long interest period. iv) You repay less each month. v) I don't know
M2	An annuity mortgage is a mortgage that keeps gross mortgage payments stable over the term of the mortgage. How does the share of interest you pay each month develop over the term of the annuity mortgage?	*i) The share of the interest decreases, and the share of your monthly repayment increases.* ii) The share of the interest increases, and the share of your monthly repayment decreases. iii) The share of interest stays stable over the period. v) I don't know.
M3	An annuity mortgage is a mortgage that keeps gross mortgage payments stable over the term of the mortgage. How does the amount that you can deduct from your income tax evolve over the term of the mortgage?	*i) You can deduct a higher amount at the beginning of the term.* ii) You can deduct a higher amount at the end of the term. iii) The amount you can deduct stays stable during the term. iv) I don't know.
M4	Suppose that you have a mortgage loan that consists of two parts: - an annuity mortgage loan part of € 50,000; - an interest-only mortgage loan part of € 150,000. You don't make any unscheduled repayments during the term. How big is your outstanding debt at the end of the term of your mortgage?	i) 0 EUR ii) 50.000 EUR iii) 100.000 EUR *iv) 150.000 EUR* iv) 200.000 EUR v) I don't know.
M5	During the term of the mortgage things can happen that lower your income. Think of disability or unemployment. Does the National Mortgage Guarantee scheme allow you to continue living in your house if you cannot pay the mortgage by yourself?	i) Yes *ii) No* iii) I don't know.

M6	You live in your own house. Last year, you paid EUR 10.000 in interest for your mortgage. Your income tax rate in the relevant bracket is 42%. How much of your mortgage interest payments can you deduct from your taxable income?	i) Less than 4.200 EUR ii) 4.200 EUR *iii) 10.000 EUR* iv) I don't know

Appendix 15 Validity tests Intellectual Virtue Scale

In this section, we confirm dimensionality analysis and internal consistency analysis for the Intellectual Virtue Scale that we conducted in previous work with the new data from the household study. The results are overall in keeping with the results of the validation study in chapter 4.

First, we tested whether the five-factor structure that we found in the validation study survived in the new sample. We conducted a principal factor analysis. Scree test and parallel analysis suggested again a five-factor solution, as illustrated by Figure 5.2.

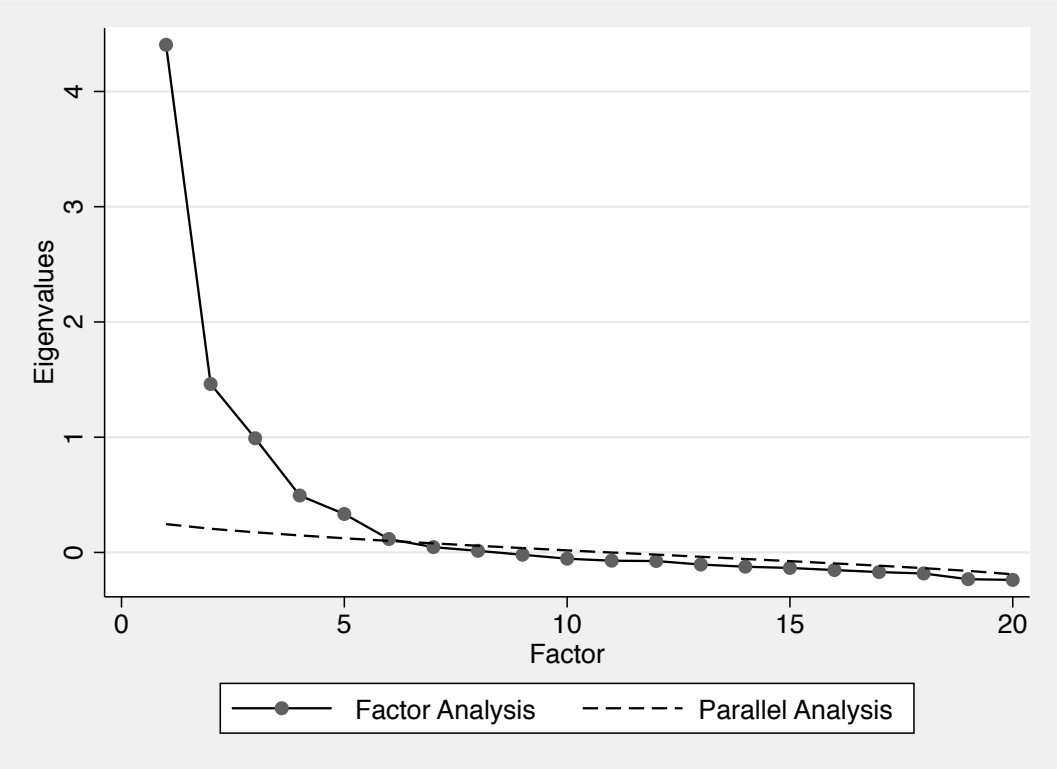

Figure 5.2: Parallel analysis for factor analysis

Figure 5.3 shows the factor loadings for a principal factor analysis of the 20 target items after an oblique oblimin rotation.

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
L1	0.77				
L2	0.76				
L3	0.68				
L4	0.67				
O1		0.34			
O2				0.39	
O3				0.41	
O4				0.39	
C1		0.62			
C2		0.68			
C3		0.67			
C4		0.59			
H1					0.38
H2					0.51
H3					0.57
H4					0.49
I1			0.55		
I2			0.51		
I3			0.55		
I4			0.56		

Figure 5.3: Factor loadings, blanks represent abs(loading)<.3

With the exception of O1, all items load on the correct factor, with no significant cross-loadings. We found that O1 loads on openness in the validation study. In this study, O1 loads instead on conscientiousness, contrary to our expectation, even if only with a loading of 0.34, below the 0.4 threshold.

Except for O2, O4, and H1, all loadings are above the 0.4 threshold that is sometimes suggested as a cut-off point (Hinkin 1995). The loading of O1 on the wrong factor notwithstanding, the factor structure of the IVS holds up well in this analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.87, a high meritorious value, which is 0.08 higher than in the confirmatory factor analysis.

Table 5.11 shows Cronbach's alpha for the subscales and the scale as a whole, as well as the item-rest correlations of the individual items with the subscales. Cronbach's alpha for the whole scale is 0.82, which falls well within the desirable range (DeVellis 2016). In the

validation study, Cronbach's alpha for the whole scale was lower in the confirmatory factor analysis (0.72). The alphas for the subscales tend also to be slightly higher than in the validation study, between 0.62 for humility and open-mindedness, and 0.84 for love of knowledge.

Table 5.11: Cronbach alphas and item-rest correlations for the items in the IVS

Name	*Alpha*/Item-Rest
Love of Knowledge	*0.84*
L1	0.69
L2	0.68
L3	0.66
L4	0.64
Open-mindedness in gathering information	*0.62*
O1	0.36
O2	0.44
O3	0.33
O4	0.45
Conscientiousness in evaluating information	*0.77*
C1	0.56
C2	0.59
C3	0.59
C4	0.52
Humility in belief formation	*0.61*
H1	0.34
H2	0.43
H3	0.42
H4	0.39
Intellectual Courage	*0.66*
I1	0.45
I2	0.40
I3	0.45
I4	0.44
Alpha whole scale	*0.82*

In sum, we find that with the exception of O1, the factor structure of the exploratory factor analysis is well replicated in the factor analysis. The internal consistency values are all well within the acceptable range.

Appendix 16 Correlation Matrix

Table 5.12: Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1 Male	1.00																												
2 Age	0.18	1.00																											
3 Net HH Income	0.14	-0.16	1.00																										
4 Wealth	0.06	0.08	0.08	1.00																									
5 SEC	0.05	-0.13	0.33	0.12	1.00																								
6 School Degree	-0.01	0.29	-0.25	-0.07	-0.51	1.00																							
7 Vocational Degree	0.01	-0.17	0.05	-0.01	0.11	-0.71	1.00																						
8 Uni	-0.01	-0.14	0.25	0.10	0.55	-0.32	-0.42	1.00																					
9 Married	0.34	0.18	0.27	0.04	-0.01	0.01	0.04	-0.06	1.00																				
10 Divorced	-0.18	0.05	-0.17	-0.03	-0.02	0.06	-0.06	-0.01	-0.33	1.00																			
11 # Children	0.01	-0.42	0.25	-0.07	0.08	-0.16	0.14	0.02	0.21	-0.02	1.00																		
12 Self-Employed	-0.04	-0.09	0.11	-0.03	0.17	-0.04	0.01	0.04	-0.03	0.00	0.02	1.00																	
13 Retired	0.19	0.70	-0.08	0.09	-0.04	0.17	-0.10	-0.09	0.14	0.01	-0.36	-0.18	1.00																
14 Unemployed	-0.08	-0.07	-0.22	-0.04	-0.05	0.02	0.00	-0.02	-0.13	0.08	-0.05	-0.07	-0.21	1.00															
15 Governement Worker	-0.04	-0.20	0.14	0.00	0.07	-0.10	0.01	0.12	0.00	-0.01	0.11	-0.07	-0.19	-0.04	1.00														
16 Risk-Proneness	0.19	-0.13	0.15	0.12	0.21	-0.15	0.01	0.19	-0.04	-0.04	0.07	0.02	-0.09	-0.03	0.04	1.00													
17 Score IVS	0.01	-0.07	0.08	0.06	0.20	-0.19	0.08	0.15	0.00	0.05	0.00	0.02	-0.01	-0.04	0.01	0.14	1.00												
18 Love of Knowledge	0.06	-0.19	0.19	0.07	0.28	-0.24	0.06	0.24	0.01	0.01	0.05	0.02	-0.09	-0.05	0.07	0.18	0.69	1.00											
19 Openness	-0.05	-0.06	0.06	0.05	0.13	-0.15	0.06	0.12	-0.04	0.06	0.00	-0.01	-0.01	-0.04	0.00	0.12	0.75	0.48	1.00										
20 Conscientiousness	-0.02	-0.08	0.09	0.05	0.14	-0.13	0.05	0.11	0.01	0.00	0.00	0.01	-0.02	-0.01	0.01	0.11	0.73	0.45	0.46	1.00									
21 Humility	-0.11	0.07	-0.10	0.01	0.02	-0.01	0.04	-0.04	-0.03	0.05	-0.07	0.04	0.07	0.02	-0.11	0.00	0.48	-0.01	0.23	0.28	1.00								
22 Courage	0.15	0.02	0.01	0.01	0.08	-0.06	0.03	0.04	0.05	0.04	0.02	0.01	0.04	-0.04	0.06	0.04	0.53	0.29	0.24	0.15	0.01	1.00							
23 Basic Fin Literacy	0.16	-0.02	0.14	0.10	0.20	-0.15	0.02	0.17	0.07	-0.03	0.05	-0.02	0.01	-0.05	0.09	0.19	0.10	0.16	0.06	0.09	-0.04	0.07	1.00						
24 Advanced Fin Literacy	0.30	0.03	0.28	0.17	0.31	-0.16	-0.01	0.22	0.12	-0.05	0.00	0.03	0.06	-0.10	0.07	0.33	0.21	0.32	0.18	0.15	-0.05	0.08	0.36	1.00					
25 Mortgage Literacy	0.19	-0.05	0.29	0.11	0.31	-0.16	0.01	0.19	0.15	-0.02	0.07	0.06	0.03	-0.13	0.07	0.21	0.17	0.29	0.15	0.11	-0.07	0.06	0.34	0.63	1.00				
26 Self-knowledge BFL	-0.15	-0.02	-0.16	-0.05	-0.17	0.12	-0.05	-0.09	-0.11	0.00	0.00	-0.04	-0.05	0.08	-0.03	-0.08	-0.12	-0.18	-0.11	-0.08	0.04	-0.06	-0.23	-0.37	-0.32	1.00			
27 Self-knowledge AFL	-0.12	-0.03	-0.06	-0.04	-0.08	0.02	0.04	-0.07	-0.01	-0.01	-0.03	0.03	-0.08	0.04	0.00	-0.05	-0.05	-0.09	-0.05	-0.04	0.05	-0.03	-0.09	-0.02	-0.09	0.06	1.00		
28 Self-knowledge ML	-0.01	0.07	-0.08	-0.03	-0.02	0.04	0.00	-0.05	-0.07	0.04	-0.03	0.02	0.06	0.01	-0.08	0.01	0.00	-0.03	0.00	0.00	0.01	0.03	-0.05	-0.03	-0.12	0.01	0.23	1.00	
29 Advisors compared?	0.01	-0.14	0.06	-0.06	0.06	-0.06	0.00	0.06	-0.09	-0.04	0.05	-0.03	-0.10	0.00	0.05	0.07	0.13	0.14	0.10	0.13	-0.05	0.10	-0.03	0.06	0.06	-0.03	0.01	-0.02	1.00

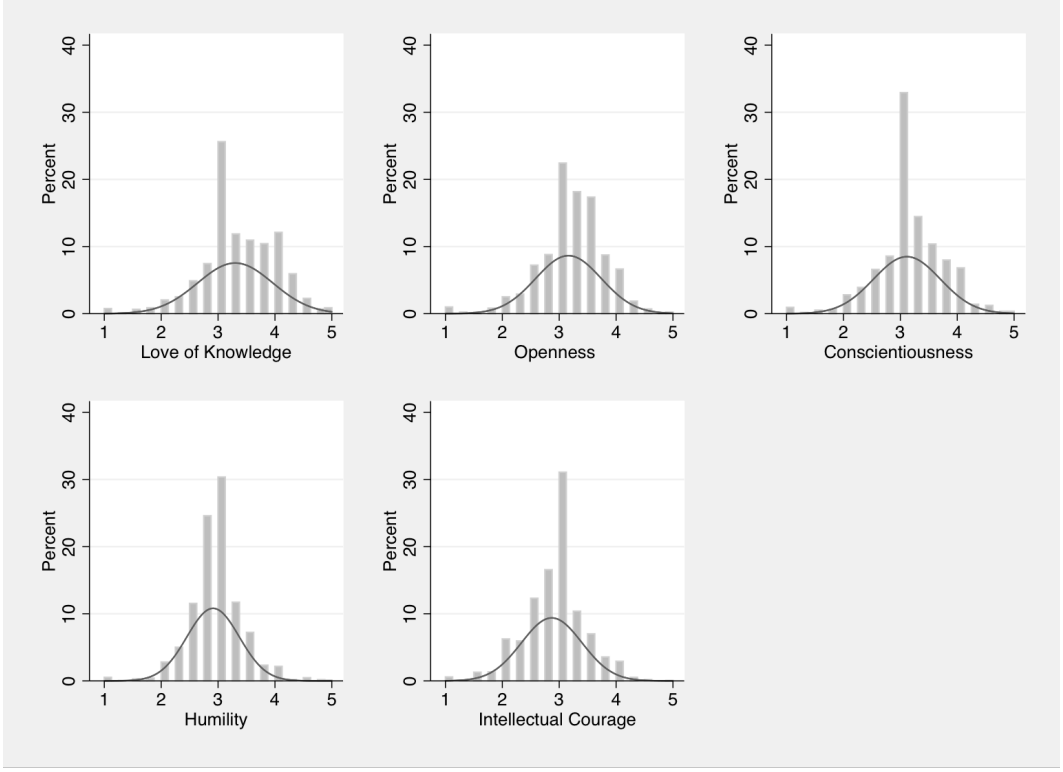

Figure 5.4: Histograms of intellectual virtue scores for individual virtues overlaid with plot of normal distribution

Table 5.13: Summary Statistics Basic Financial Literacy

Panel A: Percentage of respondents who answered individual questions correctly / incorrectly / do not know

	Question				
	1	2	3	4	5
Correct	90%	81%	88%	63%	73%
Incorrect	6%	16%	6%	29%	22%
Don't know	4%	3%	6%	8%	5%

Panel B: Percentage of respondents with respective number of correct / do not know answers

	Number of questions					
	None	1	2	3	4	5
Correct	2%	2%	6%	15%	33%	40%
Do not know	85%	9%	1%	0%	0%	1%

Table 5.14: Summary Statistics Advanced Financial Literacy

Panel A: Percentage of respondents who answered individual questions correctly / incorrectly / do not know

	Question										
	1	2	3	4	5	6	7	8	9	10	11
Correct	69%	69%	64%	63%	50%	79%	77%	30%	69%	54%	27%
Incorrect	10%	19%	13%	14%	29%	9%	13%	28%	9%	12%	38%

Panel B: Percentage of respondents with respective number of correct / do not know answers

	Number of questions											
	-	1	2	3	4	5	6	7	8	9	10	11
Correct	7%	3%	3%	6%	6%	9%	10%	13%	13%	12%	9%	9%
Do not know	11%	9%	6%	5%	4%	3%	2%	2%	1%	0%	0%	0%

Table 5.15: Summary Statistics Mortgage Literacy

Panel A: Percentage of respondents who answered individual questions correctly / incorrectly / don't know

	Questions					
	1	2	3	4	5	6
Correct	77%	60%	55%	63%	35%	24%
Incorrect	17%	21%	23%	14%	42%	43%
Don't know	6%	19%	22%	23%	23%	33%

Panel B: Percentage of respondents with respective number of correct / don't know answers

	Number of questions						
	none	1	2	3	4	5	6
Correct	11%	12%	14%	14%	22%	21%	7%
Don't Know	5%	3%	2%	1%	0%	0%	0%

Table 5.16: Statistics on self-awareness concerning financial literacy

Basic Financial Literacy

Score	N	mean	sd	p25	p50	p75	iqr	Underc	Acc.	Overc.
1	11	2.82	1.40	2	3	3	1	8%	0%	92%
2	53	2.96	1.06	2	3	4	2	7%	22%	70%
3	188	3.23	1.12	3	3	4	1	23%	34%	43%
4	465	3.74	1.26	3	4	5	2	36%	32%	32%
5	565	4.45	0.79	4	5	5	1	39%	61%	0%
Total	1282	3.94	1.17	3	4	5	2	34%	44%	22%

Advanced Financial Literacy

Score	N	mean	sd	p25	p50	p75	iqr	Underc	Acc.	Overc.
0	87	1.39	3.12	0	0	1	1	0%	65%	35%
1	35	1.09	1.29	0	1	2	2	40%	31%	29%
2	39	2.79	2.41	1	2	4	3	26%	33%	41%
3	76	3.49	2.08	2	3	5	3	38%	18%	43%
4	74	4.28	2.08	3	4	6	3	35%	16%	49%
5	111	4.74	2.16	3	5	6	3	45%	21%	34%
6	130	5.35	1.98	4	5	7	3	55%	16%	29%
7	165	6.18	2.01	5	6	8	3	54%	19%	27%
8	166	7.14	1.81	6	7	8	2	54%	21%	25%
9	158	8.15	1.79	7	8	9	2	51%	25%	23%
10	121	8.77	1.64	8	9	10	2	64%	23%	12%
11	115	9.77	1.55	9	10	11	2	57%	43%	0%
Total	1277	6.07	3.14	4	6	9	5	47%	26%	27%

Mortgage Literacy

Score	N	mean	sd	p25	p50	p75	iqr	Underc	Acc.	Overc.
0	126	1.23	1.75	0	0	2	2	0%	50%	50%
1	148	1.89	1.55	1	2	3	2	24%	20%	56%
2	179	2.51	1.32	2	3	3	1	23%	27%	51%
3	180	3.31	1.32	2	3	4	2	27%	28%	46%
4	279	3.97	1.21	3	4	5	2	36%	29%	35%
5	273	4.47	1.17	4	5	5	1	47%	32%	21%
6	87	4.96	0.94	4	5	6	2	66%	34%	0%
Total	1272	3.33	1.75	2	4	5	3	32%	31%	37%

Appendix 17 Demographic Analysis

Table 5.17: Regression Results: Demographic characteristics on IVS score

Variables	(1)
Male	-0.0370
	(0.0445)
Age (18-24 omitted)	
25-34 years	-0.7564*
	(0.4363)
35-44 years	-0.7885*
	(0.4363)
45-54 years	-0.7403*
	(0.4361)
55-64 years	-0.7773*
	(0.4351)
older than 65 years	-0.8096*
	(0.4377)
Education (School Degree omitted)	
Vocational Degree	0.1598***
	(0.0476)
University Degree	0.2221***
	(0.0761)
Log Net Household Income	0.0104
	(0.0478)
Log Wealth	0.0119*
	(0.0072)
Socioeconomic Status	0.0476*
	(0.0248)
Married	0.0775
	(0.0478)
Divorced	0.1668**
	(0.0825)
Number of Children	-0.0258
	(0.0257)
Self-Employed	0.0157
	(0.0882)
Retired	0.0350
	(0.0736)
Unemployed	-0.0930
	(0.0805)
Government Worker	-0.0844
	(0.0681)
Risk-Proneness	0.0737***
	(0.0240)
Constant	0.2900
	(0.5410)
Observations	1,062
R-squared	0.0730
Adjusted R-squared	0.0561

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Appendix 18 Robustness analysis: Financial Literacy and Financial Advisor Comparison

In section 5.4.3, we showed that intellectual virtue is significantly positively related to whether people compare different financial advisors. Here we demonstrate that no such positive relationship exists between financial literacy and advisor comparison. Table 5.18 reports the results of probit analysis with a dummy for whether people compared advisors as dependent variable. In columns 1-3, basic financial literacy, advanced financial literacy, and mortgage literacy are included as independent variables, respectively. None of the coefficient for financial literacy is significant. In the case of basic financial literacy, the coefficient is negative, indicating that more financially literate respondents are less likely to compare financial advisors, not more likely to do so. Column 4 includes all three financial literacy measures, as well as the intellectual virtue score. Basic financial literacy remains negatively related, now significant at the 5% level. In keeping with the analysis in section 5.4.3, intellectual virtue is significantly positively related, at the 1% level. These results show that financial literacy scores are not positively related with the tendency to compare financial advisors.

Table 5.18: Regression Results: Financial Literacy on comparing financial advisors

Variables	(1)	(2)	(3)	(4)
Basic Financial Literacy	-0.0918			-0.1304**
	(0.0595)			(0.0623)
Advanced Financial Literacy		0.0480		0.0308
		(0.0708)		(0.0827)
Mortgage Literacy			0.0600	0.0618
			(0.0675)	(0.0786)
Intellectual Virtue Score				0.2767***
				(0.0672)
Male	0.1970	0.1669	0.1778	0.1980
	(0.1308)	(0.1325)	(0.1305)	(0.1348)
Log Net Household Income	0.0378	0.0171	0.0270	0.0454
	(0.1573)	(0.1574)	(0.1563)	(0.1599)
Log Wealth	-0.0437*	-0.0502**	-0.0502**	-0.0560**
	(0.0228)	(0.0230)	(0.0229)	(0.0235)
Socio-Economic Status	0.0577	0.0383	0.0359	0.0123
	(0.0786)	(0.0795)	(0.0794)	(0.0817)
Married	-0.3277**	-0.3263**	-0.3354**	-0.3545**
	(0.1395)	(0.1391)	(0.1395)	(0.1419)
Divorced	-0.4412*	-0.4588*	-0.4712*	-0.5259**
	(0.2519)	(0.2534)	(0.2539)	(0.2567)
Number of Children	0.0084	0.0085	0.0077	0.0028
	(0.0655)	(0.0654)	(0.0655)	(0.0664)
Self-Employed	-0.3403	-0.3149	-0.3129	-0.3728
	(0.2627)	(0.2622)	(0.2617)	(0.2733)
Retired	-0.0768	-0.0934	-0.0920	-0.0582
	(0.2417)	(0.2417)	(0.2415)	(0.2437)
Unemployed	-0.0348	-0.0418	-0.0181	-0.0145
	(0.2892)	(0.2892)	(0.2898)	(0.2927)
Government Worker	0.1538	0.1410	0.1429	0.1850
	(0.1755)	(0.1747)	(0.1749)	(0.1787)
Risk-Proneness	0.0634	0.0408	0.0435	0.0350
	(0.0713)	(0.0727)	(0.0715)	(0.0738)
Age (18-34 omitted)				
35-44 years	0.0404	0.0511	0.0522	0.0263
	(0.2256)	(0.2252)	(0.2254)	(0.2278)
45-54 years	-0.0892	-0.0867	-0.0802	-0.1678
	(0.2255)	(0.2251)	(0.2254)	(0.2286)
55-64 years	-0.0851	-0.0813	-0.0759	-0.1627
	(0.2306)	(0.2301)	(0.2304)	(0.2332)
older than 65 years	-0.2482	-0.2243	-0.2135	-0.3396
	(0.3029)	(0.3023)	(0.3027)	(0.3056)
Education (School Degree omitted)				
Vocational Degree	-0.0868	-0.0854	-0.0832	-0.0994
	(0.1452)	(0.1455)	(0.1455)	(0.1474)
University Degree	0.0678	0.0542	0.0514	0.0340
	(0.2220)	(0.2220)	(0.2220)	(0.2256)
Constant	-0.5452	-0.2430	-0.3298	-0.2756
	(1.2136)	(1.2257)	(1.2052)	(1.2389)
Observations	679	679	679	677
Pseudo R-squared	0.0396	0.0371	0.0375	0.0652

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

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option available seemed to be to develop and validate a new instrument from scratch. Little did I realize the amount of effort going into properly validating a psychometric measure.

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Marco Meyer,

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Summary

The overarching research question of the thesis is whether and to what extent individual characteristics affect economic decision making. The chapters separately address the following research questions:

Chapter 2: Does personality affect risk taking, investment decisions, and desire for credit?
Chapter 3: Does knowledge about mortgages affect the riskiness of mortgages taken?
Chapter 4: How can intellectual virtue be measured?
Chapter 5: Does intellectual virtue improve knowledge about finance and financial diligence?

In chapter 2, we investigate how personality influences economic decision making, with a lab-in-the-field experiment as well as observational data from rural Kenya. Our sample is composed of smallholders with an income of less than $1 per day, from 40 farmer communities in Meru County. More than 90% are women. We find that particular personality profiles are associated with the risk propensity of farmers, their investment decisions, their desire for credit, and the amount of formal and informal credit they obtain. Interestingly, we find that other traits matter than those suggested by the existing literature. We find no correlation with the traits of neuroticism and extroversion, which have been identified as important in developed country studies. By contrast, agreeableness, conscientiousness, and intellect are significantly correlated with our outcome measures. These results shed new light on the relationship between personality traits and economic decisions, and contribute to the understanding of how personality shapes investment decisions and risk taking in a poor rural context.

In chapter 3, we study the relationship between mortgage literacy and mortgage risks with a newly designed Mortgage Literacy Questionnaire using Dutch household data. The Mortgage Literacy Questionnaire evaluates the domain-specific knowledge of households about mortgages, including the legal and fiscal implications of different types of mortgages. We find that mortgage literacy is distinct from basic and advanced financial literacy. A significant number of households is financially literate but mortgage illiterate. We demonstrate that mortgage literacy is associated with lower perceived mortgage risk, and with how well households hedge mortgage risk. Our results suggest that knowledge about mortgage products and their legal and fiscal environment matters considerably for financial choices regarding mortgages.

In chapter 4, we develop and validate the Intellectual Virtue Scale, a new measure of intellectual virtues. Intellectual virtues are acquired character traits that support gaining knowledge and understanding. We develop a 20-item scale, measuring five intellectual virtues with four items each: love of knowledge, openness in gathering information, conscientiousness in processing information, humility in belief formation, and intellectual courage. The validation studies include an exploratory and a confirmatory factor analysis with almost 1,000 participants each, demonstrating that the Intellectual Virtue Scale has a stable factor structure and is internally reliable. We also demonstrate that intellectual virtue is distinct from related constructs such as personality, moral virtue, critical thinking, and professional scepticism.

In chapter 5, we study the relationship between the Intellectual Virtue Scale and financial knowledge and diligent financial decision making. A substantial body of literature suggests that people who are more financially literate make better financial decisions. We study the intellectual qualities supporting financial literacy. In particular, we investigate whether intellectual virtue is associated with greater financial literacy and with a more reflective and conscientious approach to financial decision making. We measure the extent to which participants in a representative Dutch household panel display intellectual virtue using the Intellectual Virtue Scale. We find that intellectually virtuous people are more financially literate, display greater self-awareness about their financial knowledge, and are more likely to compare financial advisors.

Each chapter deals with the problem of measurement, if in different ways. Chapter 2 uses an existing and well-studied measure of personality based on the Big Five personality traits, but applies it in a new context, namely a developing country. While we rely on an existing instrument, administering the instrument in a very different cultural context yields new insights. Chapter 3 investigates the relationship between knowledge and mortgage decisions through the lens of a newly developed instrument, the Mortgage Literacy Questionnaire. The Mortgage Literacy Questionnaire is the first instrument to measure financial literacy that includes questions on different mortgage types, including their fiscal and legal implications. Chapter 4 develops and validates the Intellectual Virtue Scale, a new instrument to measure intellectual virtue. In chapter 5, we use the Intellectual Virtue Scale to inquire into the associations of intellectual virtue with financial literacy, as well as diligent financial decision making.

While each chapter stands on its own, the crosscutting theme of the economic consequences of individual characteristics deserves attention. Individual characteristics were long neglected among the factors influencing economic decision making. The long dominant approach in economics regarded people as rational agents on a quest to maximize utility. People's utility function was determined by a stable, complete, and transitive preference ordering over all available choices. It was not the place of economics to further inquire into the origin of these preferences. Within this paradigm, economists derived general predictions about economic behaviour based on given preferences and prices, which itself were the results of supply and demand on clearing markets. Individual characteristics such as personality, knowledge, and other cognitive characteristics were excluded from the analysis. This thesis contributes to putting these individual characteristics, always at play in economic decision making, into the study of economic decision making.

Samenvatting

De hoofdvraag in dit proefschrift is of, en zo ja, in welke mate persoonlijke kenmerken economische besluitvorming beïnvloeden. De volgende deelvragen worden in afzonderlijke hoofdstukken behandeld:

Hoofdstuk 2: Heeft persoonlijkheid invloed op het accepteren van risico's, het nemen van investeringsbeslissingen, en de behoefte aan financiering?
Hoofdstuk 3: Beïnvloedt kennis van zaken met betrekking tot hypotheken het risicogehalte van de hypothecaire lening die wordt aangegaan?
Hoofdstuk 4: Hoe kan intellectuele deugd worden gemeten?
Hoofdstuk 5: Heeft intellectuele deugd een gunstig effect op financiën en het verantwoord omgaan met geld?

In hoofdstuk 2 wordt op basis van veldonderzoek en een observatiestudie op het platteland van Kenia onderzocht hoe persoonlijkheid economische besluitvorming beïnvloedt. Onze steekproef bestaat uit kleine boerenbedrijven in 40 boerengemeenschappen in Meru County met een inkomen van minder dan $1 per dag. Negentig procent is hier vrouw. Wij zien dat er een relatie is tussen bepaalde persoonlijkheidsprofielen van de boeren en hun risicobereidheid, hun investeringsbeslissingen, hun financieringsbehoeften, en de hoeveelheid formeel en informeel krediet die zij krijgen. Interessant is dat hele andere kenmerken een rol blijken te spelen dan vooralsnog wordt gesuggereerd in de literatuur. Zo hebben wij geen correlaties gevonden met de kenmerken neuroticisme en extraversie, die in studies over ontwikkelde landen als belangrijke factoren worden aangewezen. Onze resultaten laten daarentegen zien dat eigenschappen zoals innemendheid, zorgvuldigheid en intellect van belang zijn. Deze bevinding werpt nieuw licht op de relatie tussen persoonlijkheidskenmerken en economische besluitvorming. En hiermee draagt zij bij aan het vergroten van het inzicht in de vraag hoe de persoonlijkheidsstructuur van mensen in arme landelijke gebieden hun beslissingen beïnvloedt met betrekking tot het doen van investeringen en het nemen van risico's.

In hoofdstuk 3 wordt de relatie bestudeerd tussen hypotheek-geletterdheid en het risicogehalte van hypotheken. Hiervoor hebben wij een Hypotheek-Geletterdheid-Vragenlijst (Mortgage Literacy Questionnaire) ontworpen op basis van gegevens uit Nederlandse huishoudens. De

vragenlijst evalueert de domein-specifieke kennis die huishoudens hebben van hypotheken, met inbegrip van de wettelijke en fiscale consequenties van de verschillende typen hypotheken.

Wij zien dat er een verschil bestaat tussen hypotheek-geletterdheid en financiële geletterdheid. Een groot aantal huishoudens is financieel geletterd, maar ongeletterd als het gaat om hypotheken. Onze studie toont aan dat hypotheek-geletterdheid gepaard gaat met een lagere inschatting van het risico van de hypotheek. Daarbij is er een verband tussen hypotheek-geletterdheid en de manier waarop huishoudens hun hypotheek-risico afdekken. Onze resultaten suggereren dat de aanwezige kennis van hypotheekproducten in hun wettelijke en fiscale context aanzienlijk van invloed is op het maken van financiële keuzes op het gebied van hypotheken.

Hoofdstuk 4 beschrijft de ontwikkeling en validatie van een Intellectuele-Deugden-Schaal (Intellectual Virtue Scale), een nieuw instrument voor het meten van intellectuele deugd.

Intellectuele deugden zijn aangeleerde karakter-kenmerken die het verwerven van kennis en inzicht stimuleren. Wij ontwikkelden een 20-eenheden-schaal die vijf intellectuele deugden meet, elk onderverdeeld in vier sub-eenheden: voorliefde voor kennis, openheid in het verzamelen van informatie, het nauwkeurig verwerken van informatie, bedachtzaamheid in het ontwikkelen van opvattingen, en intellectuele moed. De validatiestudies omvatten een explorerende en een bevestigende factor-analyse met elk zo'n 1000 deelnemers. Hiermee wordt aangetoond dat de eenhedenstructuur van de Intellectuele-Deugden-Schaal stabiel en intern betrouwbaar is. We tonen ook aan dat er een verschil is tussen intellectuele deugd en gerelateerde begrippen zoals persoonlijkheid, morele integriteit, kritisch denken, en professioneel scepticisme.

Hoofdstuk 5 bestudeert de relatie tussen de Intellectuele-Deugden-Schaal enerzijds en financiële kennis en doordachte financiële besluitvorming anderzijds. Veel publicaties stellen dat mensen die financieel meer geletterd zijn betere financiële beslissingen maken. Deze studie onderzoekt welke intellectuele capaciteiten financiële geletterdheidstimuleren. Er wordt in het bijzonder gekeken of er een relatie is tussen intellectuele deugd en een hogere mate van geletterdheid in combinatie met een meer bedachtzame en nauwkeurige manier van financiële besluitvorming. Op basis van de Intellectuele-Deugden-Schaal meten wij de mate waarin leden van een representatief huishouden-panel intellectuele deugden tonen. Het blijkt dat personen met intellectuele deugden financieel geletterder zijn. Tevens zijn zij zelfbewuster wat betreft

hun financiële kennis, en meer geneigd om een vergelijking te maken tussen verschillende financiële adviseurs.

Alle hoofdstukken in dit proefschrift zijn gericht op het meten van hypotheek-geletterdheid, zij het vanuit een andere invalshoek. In hoofdstuk 2 wordt een bestaand en gevalideerd meetinstrument, gebaseerd op de Grote Vijf persoonlijkheidskenmerken, gebruikt in een nieuwe context, namelijk die van een ontwikkelingsland. Het toepassen van een bestaand instrument in een afwijkende culturele context levert nieuwe inzichten op. Hoofstuk 3 onderzoekt de relatie tussen kennis en hypotheek-besluitvorming met behulp van een nieuw meetinstrument, de Hypotheek-Geletterdheid-Vragenlijst (Mortgage Literacy Questionnaire). Deze vragenlijst is de eerste die financiële geletterdheid meet op basis van vragen over verschillende hypotheek-typen en hun fiscale en juridische aspecten. Hoofdstuk 4 beschrijft de ontwikkeling en validatie van de Intellectuele-Deugden-Schaal, een nieuw instrument voor het meten van intellectuele deugd. In hoofdstuk 5 wordt de Intellectuele-Deugden-Schaal gebruikt om te onderzoeken of intellectuele deugden een relatie met financiële geletterdheid en weloverwogen financiële besluitvorming hebben.

Hoewel elk hoofdstuk op zichzelf staat, is het centrale thema in dit proefschrift de invloed van persoonlijke kenmerken op de economische besluitvorming van individuen. Als factoren die de economische besluitvorming beïnvloeden hebben persoonlijke kenmerken lange tijd geen aandacht gekregen in de literatuur. In de gangbare economische theorieën worden personen in het algemeen beschouwd als rationele agenten die streven naar nutsmaximalisatie. Volgens deze theorieën wordt de nutsfunctie van consumenten bepaald door een stabiele, volledige en transitieve ordening van aanwezige alternatieven op basis van voorkeuren. De achterliggende redenen voor deze voorkeuren worden echter niet beschouwd als een thema binnen het domein van de economie. Hier gelden vooral algemene voorspellingen over economisch gedrag op basis van voorkeuren en prijzen, die op zich weer het resultaat zijn van aanbod en vraag in een situatie van marktequilibrium. Individuele kenmerken zoals persoonlijkheid, kennis, en andere cognitieve eigenschappen worden hier niet bij betrokken.